ELSINORE VALLEY MUNICIPAL WATER DISTRICT

Elsinore Basin Groundwater Management Plan

June 2003

MWH

ACKNOWLEDGEMENTS

The development of the Elsinore Basin Groundwater Management Plan could not have been possible without the dedication of the project team and the support of the District staff and Technical Review Committee. MWH would like to acknowledge the following people for their support and assistance in completing the project.

Elsinore Valley Municipal Water District
Ronald E. Young, General Manager
Phillip M. Miller, District Engineer
Margie Armstrong, Controller
Joe Mouawad, Senior Engineer
Greg Morrison, Director of Legislative and Community Affairs

Technical Review Committee
Behrooz Mortazavi, Eastern Municipal Water District
Carl Hauge, California Department of Water Resources
Roger Shintaku, Elan Associates
Roy Herndon, Orange County Water District

MWH Project Staff
Ajit Bhamrah, Principal-In-Charge
Mark Abbott, Project Manager
David Ringel, Senior Technical Advisor
Don Evenson, Criteria Committee
Harold Glaser, Criteria Committee
Chris Peterson, Criteria Committee
Inge Wiersema, Project Engineer
Matthew Hacker, Project Hydrogeolist
Dawn York, Project Administrator
Beth McDonough
Adam Norris
Matthew Huang
Alok Pandya
Bonnie Lind
Christine Geasler
Genevieve Fernandez
Lissa McVean
Tracy Wilcox

California Department of Water Resources
Dale Schafer, California Center for Public Dispute Resolution
Eric Hong, Supervising Engineer
Mansour Hojabry, Civil Engineer
Samson Haile-Selassie, Water Resources Engineer

Table of Contents

Page No.

EXECUTIVE SUMMARY
Study Area....ES-1
Need for Groundwater Management Plan....ES-2
Hydrogeologic Understanding of the Elsinore Basin....ES-3
Fault System....ES-3
Geology....ES-4
Groundwater Balance....ES-5
Water Quality....ES-5
Baseline Conditions....ES-6
Groundwater Management Issues....ES-8
Groundwater Management Strategies....ES-8
Description of Alternatives....ES-9
Alternative 1....ES-9
Alternative 2....ES-9
Alternative 3....ES-13
Alternative 4....ES-13
Evaluation of Alternatives....ES-13
Ability to Reduce Overdraft....ES-14
Estimated Cost....ES-19
Conclusion of Alternative Evaluation....ES-19
Implementation Plan....ES-20
Conjunctive Use with Dual-Purpose Wells....ES-20
Lake Replenishment with Recycled Water....ES-20
Basin Monitoring Plan....ES-22
Advisory Committee....ES-22
Septic Tank Conversion Policies....ES-23
Cost of Recommended Plan....ES-23
Conclusions....ES-23

SECTION 1 INTRODUCTION
Scope of Work....1-1
Study Area....1-1
Project Background....1-5
Project Objectives....1-6
Regional Setting of Elsinore Basin....1-7
Elsinore Groundwater Basin....1-7
Lake Elsinore....1-8
Canyon Lake....1-9
Imported Water Supplies....1-9
Wastewater and Recycled Water....1-10
Potable Demands....1-10
Non-Potable Demands....1-10
Summary....1-10
Report Overview....1-10

Table of Contents

Page No.

SECTION 2 HYDROGEOLOGIC SETTING

Background ... 2-1
Previous Work ... 2-1
Data Collection ... 2-2
Data Organization ... 2-2
Data Sources ... 2-3
Well Information ... 2-3
Data Assessment ... 2-5
Geology and Structure ... 2-5
Geologic Setting ... 2-5
Hydrostratigraphy ... 2-7
Recent Alluvium ... 2-7
Older Alluvium ... 2-9
Fernando Group ... 2-9
Bedford Canyon Formation ... 2-9
Undifferentiated Basement Complex ... 2-9
Structure ... 2-10
Faults ... 2-10
Conceptual Hydrogeologic Sections ... 2-10
Aquifer Characteristics ... 2-20
Groundwater Levels ... 2-22
General Groundwater Flow ... 2-22
Historical Groundwater Levels ... 2-26
Fernando Group ... 2-26
Alluvium and Fernando Group ... 2-26
Groundwater Budget ... 2-26
Inflows ... 2-28
Precipitation Recharge ... 2-28
Surface Water Recharge ... 2-33
Recharge through Water Use ... 2-36
Outflows ... 2-37
Evapotranspiration by Phreatophytes ... 2-38
Groundwater Pumping ... 2-38
Surface Outflows ... 2-38
Subsurface Outflows ... 2-39
Water Budget Summary ... 2-39
Groundwater Quality ... 2-40
Summary and Next Steps ... 2-44

SECTION 3 GROUNDWATER MODEL

Model Construction ... 3-1
Model Domain ... 3-1
Model Layer Discretization ... 3-3

Page No.

Aquifer Parameters 3-5
Boundary Conditions 3-8
Hydrologic Stresses 3-8
Model Calibration........ 3-9
Calibration Wells 3-12
Results........ 3-12
Lincoln Street Well 3-12
North Island Well........ 3-12
South Island Well........ 3-13
Cereal 4 Well 3-13
Cereal 3 Well 3-13
Cereal 1 Well 3-13
Corydon Well 3-13
Olive Street Well 3-14
Palomar Well 3-14
Calibration Analysis 3-14
Sensitivity Analysis 3-15
Summary 3-16
Model Limitations 3-16
Summary and Recommendations........ 3-17

SECTION 4 BASELINE CONDITIONS
Introduction........ 4-1
Baseline Conditions........ 4-2
Baseline A – Current Basin Conditions........ 4-3
Planning Assumptions........ 4-4
Groundwater Balance........ 4-6
Water Levels........ 4-7
Baseline B – Year 2020 Basin Conditions........ 4-8
Planning Assumptions........ 4-9
Groundwater Balance........ 4-12
Water Levels........ 4-13
Need for Management Plan........ 4-15

SECTION 5 MANAGEMENT ISSUES AND STRATEGIES
Introduction........ 5-1
Groundwater Management Issues 5-2
AB3030 Issues and Components........ 5-3
1. Saline Water Intrusion........ 5-3
2. Wellhead Protection 5-3
3. Migration of Contaminated Groundwater 5-5
4. Well Construction Policies 5-7
5. Well Abandonment and Destruction........ 5-7

Page No.

6. Construction of Groundwater Projects 5-8
7. Impact of Land Use Plans on Groundwater Contamination 5-9
8. Mitigation of Overdraft Conditions 5-9
9. Replenishment of Extracted Groundwater 5-10
10. Monitoring of Groundwater Production, Levels, Storage, and Water Quality 5-11
11. Facilitating Conjunctive Use Operations 5-11
12. Develop Relationships with Regulatory Agencies 5-11

Other Management Issues 5-11

1. Compliance with Drinking Water Quality Regulations and Basin Plan Objectives 5-12
2. Doubling of Water Demand in the Next 20 Years 5-12
3. Lake Replenishment Requirements 5-14
4. Impact of Future Basin Operations on Hot Springs 5-14
5. Risk of Liquefaction 5-14

Groundwater Management Strategies And Activities 5-15

Dual Purpose Wells 5-15

Possible Locations 5-15

Recharge Potential 5-16

Operation 5-18

Implementation 5-19

Surface Spreading 5-20

McVicker Canyon 5-20

Leach Canyon 5-23

Railroad Canyon 5-24

In-Lieu Recharge 5-25

New Sources of Supply 5-25

San Jacinto Raw Water Turnout 5-25

Local Runoff 5-26

Regional WWTP 5-26

Wastewater from EMWD 5-27

Water Conservation 5-27

Low Water Use Landscaping 5-27

Increase Awareness and Financial Incentives 5-29

Basin Monitoring 5-31

Stakeholder Involvement 5-31

Groundwater Quality Protection Programs and Policies 5-32

Wellhead Protection Program 5-32

Well Construction and Abandonment Program 5-32

Septic Tank Conversion Policies 5-33

Land Development Plans 5-33

Activities Not Considered 5-33

Page No.

SECTION 6 DESCRIPTION OF ALTERNATIVES
Modeling assumptions 6-1
Groundwater Model 6-1
Hydraulic Model 6-6
Alternative 1 – Dual Purpose Wells 6-7
Water Demands 6-7
Water Supplies 6-7
Septic Tanks 6-11
Lake Replenishment 6-11
Alternative 2 – Surface Spreading 6-11
Water Demands 6-11
Water Supplies 6-12
Alternative 3 – In-lieu Recharge 6-16
Water Demands 6-17
Water Supply 6-17
Alternative 4 – Combination Alternative 6-18
Water Demands 6-19
Water Supplies 6-19
Lake Replenishment 6-21

SECTION 7 - EVALUATION OF ALTERNATIVES
Introduction 7-1
Evaluation Criteria 7-1
Ability to Reduce Overdraft 7-3
Expected Cost 7-3
Environmental Impacts 7-6
Risk 7-6
Legal and Regulatory Issues 7-6
Public Acceptability 7-7
Funding 7-7
Reliability 7-7
Water Quality 7-8
Flexibility 7-8
Ease of Implementation 7-9
Evaluation of Alternatives 7-9
Ability to Reduce Overdraft 7-9
Expected Cost 7-15
Environmental Impacts 7-18
Risk 7-19
Legal and Regulatory Issues 7-21
Public Acceptability 7-23
Funding 7-24
Reliability 7-25

Water Quality 7-25
Flexibility 7-26
Ease of Implementation 7-28
Selection of Preferred Alternative 7-28

SECTION 8 - IMPLEMENTATION PLAN
Introduction 8-1
Components of the recommended plan 8-1
Water Conservation 8-1
Groundwater Recharge with Dual Purpose Wells 8-4
Other Facilities 8-4
Lake Level Maintenance 8-5
Surface Spreading 8-5
Use of Recycled Water 8-5
Advisory Committee 8-6
Monitoring Program 8-6
Well Construction, Destruction and Abandonment Policies 8-7
Septic Tank Conversion Plan and Policies 8-9
Implementation 8-9
Costs of the Recommended Plan 8-9
Funding Options 8-10
Phasing of Activities 8-10
Phasing of Cost 8-11
Operation of the Basin 8-12
Agency Coordination 8-14
Conclusion 8-14

APPENDICES
Appendix A – References
Appendix B – List of Abbreviations
Appendix C – Structural Contour Map
Appendix D – Model Calibration Results
Appendix E – Lake Replenishment Analysis
Appendix F – Groundwater Management Issues
Appendix G – Details on Water Conservation Programs
Appendix H – Cost Estimates
Appendix I – Model Results of Alternatives

List of Tables

Page No.

LIST OF TABLES

Table ES-1 Summary of Baselines A and B 6
Table ES-2 Summary of Alternatives 11
Table ES-3 Summary of Alternatives Evaluation 15
Table ES-4 Cost Summary per Alternative 19
Table ES-5 Summary of Estimated Cost of the Recommended Plan 24

Table 1-1 Operational Data for Lake Elsinore 1-8

Table 2-1 Data Sources 2-3
Table 2-2 Summary of Aquifer Characteristics 2-21
Table 2-3 Summary of Groundwater Elevations – Summer 2002 2-23
Table 2-4 Evapotranspiration Constants for Elsinore Basin 2-31
Table 2-5 Summary of Estimated Groundwater Basin Budget for 1990-2000 2-39

Table 3-1 Aquifer Property Model Input Parameters 3-6
Table 3-2 Summary of Wells in Flow Model 3-9

Table 4-1 Potable Water Demands in the Elsinore Basin – Year 2000 4-1
Table 4-2 Potable Water Demands in the Elsinore Basin – Baseline A 4-4
Table 4-3 Summary of Groundwater Balance – Baseline A 4-6
Table 4-4 Potable Water Demands in the Elsinore Basin – Baseline B 4-10
Table 4-5 Range of Lake Replenishment Requirements – Baseline B 4-12
Table 4-6 Summary of Groundwater Balance – Baseline B 4-13

Table 5-1 List of Potential Management Issues 5-4
Table 5-2 Specific Water Quality Objectives for Elsinore Basin 5-13
Table 5-3 Management Activities and Water Sources Considered 5-16
Table 5-4 Summary of Recharge Potential with Dual Purpose Wells 5-18
Table 5-5 McVicker Canyon Surface Spreading Potential 5-22
Table 5-6 Leach Canyon Surface Spreading Potential 5-23
Table 5-7 Estimated Irrigation Savings with Low Water Use Landscaping 5-28
Table 5-8 Estimated Water Savings with Awareness and Financial Incentives 5-30

Table 6-1 Summary of Alternatives 6-3
Table 6-2 Summary of Average Groundwater Balance for 2020 6-5
Table 6-3 Maximum Injection and Extraction Capacities 6-6
Table 6-4 Projected Average Supplies and Demands for 2020 6-8
Table 6-5 Summary of Projected Lake Elsinore Balance for 2020 6-9
Table 6-6 Cost Comparison Surface Spreading Water Sources 6-14

List of Tables

Page No.

Table 7-1 Evaluation Criteria 7-2
Table 7-2 Summary of Water Supply Cost 7-5
Table 7-3 Summary of Alternative Evaluation 7-11
Table 7-4 Cost Summary per Alternative 7-16
Table 7-5 Cost Summary per Alternative per acre-foot of overdraft reduction 7-18
Table 7-6 Reliability of Alternatives 7-25
Table 7-7 Water Quality Summary 7-26
Table 7-8 Summary of Alternative Rating 7-29
Table 7-9 Summary of Alternative Ranking 7-29

Table 8-1 Summary of Dual Purpose Wells 8-4
Table 8-2 Summary of Capital and Annual Cost 8-9
Table 8-3 Phasing of Capital Cost (in $1,000) 8-11
Table 8-4 Summary of Agency Coordination 8-15

Page No.

LIST OF FIGURES

Figure ES-1 Study Area 1
Figure ES-2 Projected Water Demands of EVMWD and EWD 2
Figure ES-3 Location of Wells and Faults in the Elsinore Basin 3
Figure ES-4 Geology of the Elsinore Basin 4
Figure ES-5 Elsinore Basin Groundwater Budget 1990-2001 5
Figure ES-6 Projected Cumulative Groundwater Balance for Baselines A and B 7
Figure ES-7 Projected Groundwater Levels for Baseline B 7
Figure ES-8 Comparison Chart for the North Island Well 14
Figure ES-9 Components of the Recommended Plan 21
Figure ES-10 Water Supply Mix during an Average Rainfall Year 22

Figure 1-1 Study Area 1-2
Figure 1-2 Locations of Key Facilities in the Elsinore Basin 1-3
Figure 1-3 Water Flows in the Elsinore Basin 1-8

Figure 2-1 Wells in the Elsinore Basin 2-4
Figure 2-2 Faults of the Elsinore Basin 2-6
Figure 2-3 Hydrostratigraphy in the Elsinore Basin 2-7
Figure 2-4 Geology of the Elsinore Basin 2-8
Figure 2-5 Location of Cross Sections 2-11
Figure 2-6 Cross Section A-A' 2-13
Figure 2-7 Cross Section B-B' 2-15
Figure 2-8 Cross Section C-C' 2-17
Figure 2-9 Groundwater Contour Map Fernando Group – Summer 2002 2-24
Figure 2-10 Groundwater Level Map Alluvium and Fernando Group– Summer 2002 2-25
Figure 2-11 Historical Water Levels in the Fernando Group 2-27
Figure 2-12 Historical Water Levels in the Alluvium and the Fernando Group 2-27
Figure 2-13 Isohyetal Map of Elsinore Watershed 2-30
Figure 2-14 Historical Annual Precipitation RCFCD – Station 67 2-31
Figure 2-15 Vegetation Distribution in the Elsinore Basin 2-32
Figure 2-16 Land Use in Elsinore Watershed 2-34
Figure 2-17 Annual Estimated Groundwater Recharge from Precipitation (1990-2000) 2-35
Figure 2-18 Historical Annual Streamflow at San Jacinto River (1916-2000) 2-35
Figure 2-19 Estimated Groundwater Recharge from the San Jacinto River (1990-2000) 2-36
Figure 2-20 Estimated Groundwater Recharge through Water Use (1990-2000) 2-37
Figure 2-21 Historical Groundwater Pumping in the Elsinore Basin 2-38
Figure 2-22 Total Estimated Inflows and Outflows to Groundwater Basin 2-40
Figure 2-23 Piper Diagram in the Elsinore Basin 2-41
Figure 2-24 Historical Total Dissolved Solids Concentrations in Elsinore Basin Wells 2-42
Figure 2-25 Historical Sulfate Concentrations in Wells in the Elsinore Basin 2-42
Figure 2-26 Historical Nitrate Concentrations in Wells in the Elsinore Basin 2-43
Figure 2-27 Historical Arsenic Concentrations in Elsinore Basin Wells 2-43

List of Figures

Page No.

Figure 3-1 Model Domain and Grid Discretization ... 3-2
Figure 3-2 Longitudinal Cross Section Through Flow Model ... 3-4
Figure 3-3 Hydraulic Conductivity Distribution, Model Layers 1 and 3 ... 3-7
Figure 3-4 Calibration and Pumping Well Location Map ... 3-10
Figure 3-5 Relative Goodness of Fit for Groundwater Model ... 3-11
Figure 3-6 Modeled Difference in Water Level Between Layer 1 and Layer 3 ... 3-15

Figure 4-1 Summary of Projected Potable Water Demands through 2020 ... 4-2
Figure 4-2 Annual Precipitation at Lake Elsinore ... 4-3
Figure 4-3 Summary of Supplies to Meet Projected Demands – Baseline A ... 4-5
Figure 4-4 Projected Cumulative Groundwater Balance - Baseline A ... 4-7
Figure 4-5 Projected Water Levels of Baseline A – Existing Conditions ... 4-8
Figure 4-6 Supply Mix to Meet the Projected Year 2020 with Sustainable Groundwater Balance – Baseline A ... 4-9
Figure 4-7 Supply Mix to Meet the Projected Year 2020 Demands – Baseline B ... 4-10
Figure 4-8 Summary of Lake Replenishment Requirements for Baseline B ... 4-11
Figure 4-9 Projected Cumulative Groundwater Balance - Baselines A and B ... 4-14
Figure 4-10 Projected Water Levels of Baseline B – Future Conditions ... 4-14
Figure 4-11 Supply Mix to Meet Year 2020 Demands with Sustainable Groundwater Balance– Baseline B ... 4-15

Figure 5-1 Process to Define Management Alternatives ... 5-1
Figure 5-2 Septic Tank Risk Zones ... 5-6
Figure 5-3 Location of Dual Purpose Wells ... 5-17
Figure 5-4 Total Replenishment Supplies Available from MWDSC (1961-1998) ... 5-19
Figure 5-5 Potential Recharge Locations ... 5-21

Figure 6-1 Injection and Extraction Cycles of Alternative 1 ... 6-10
Figure 6-2 Year 2020 Potable Supplies with Alternative 1 ... 6-10
Figure 6-3 Surface Spreading and Extraction Cycles Alternative 2 ... 6-15
Figure 6-4 Year 2020 Potable Supplies for Alternative 2 ... 6-15
Figure 6-5 Supply Mix to Meet Year 2020 Demands with Sustainable Groundwater Balance– Alternative 2 ... 6-16
Figure 6-6 Groundwater Pumping and In-Lieu Recharge – Alternative 3 ... 6-17
Figure 6-7 Year 2020 Potable Supplies for Alternative 3 ... 6-18
Figure 6-8 Groundwater Pumping and Injection – Alternative 4 ... 6-20
Figure 6-9 Supply of Year 2020 Demand with Alternative 4 ... 6-20

Figure 7-1 Water Level Comparison – Lincoln Street Well ... 7-9
Figure 7-2 Water Level Comparison – North Island Well ... 7-10
Figure 7-3 Water Level Comparison – Corydon Well ... 7-10

Page No.

Figure 8-1 Components of the Recommended plan 8-2
Figure 8-2 Location of Monitoring Wells 8-8
Figure 8-3 Phasing of Activities 8-11
Figure 8-4 Water Supply Mix during an Average Rainfall Year 8-13
Figure 8-5 Water Supply Mix during a Wet Year 8-13
Figure 8-6 Water Supply Mix during a Dry Year 8-14

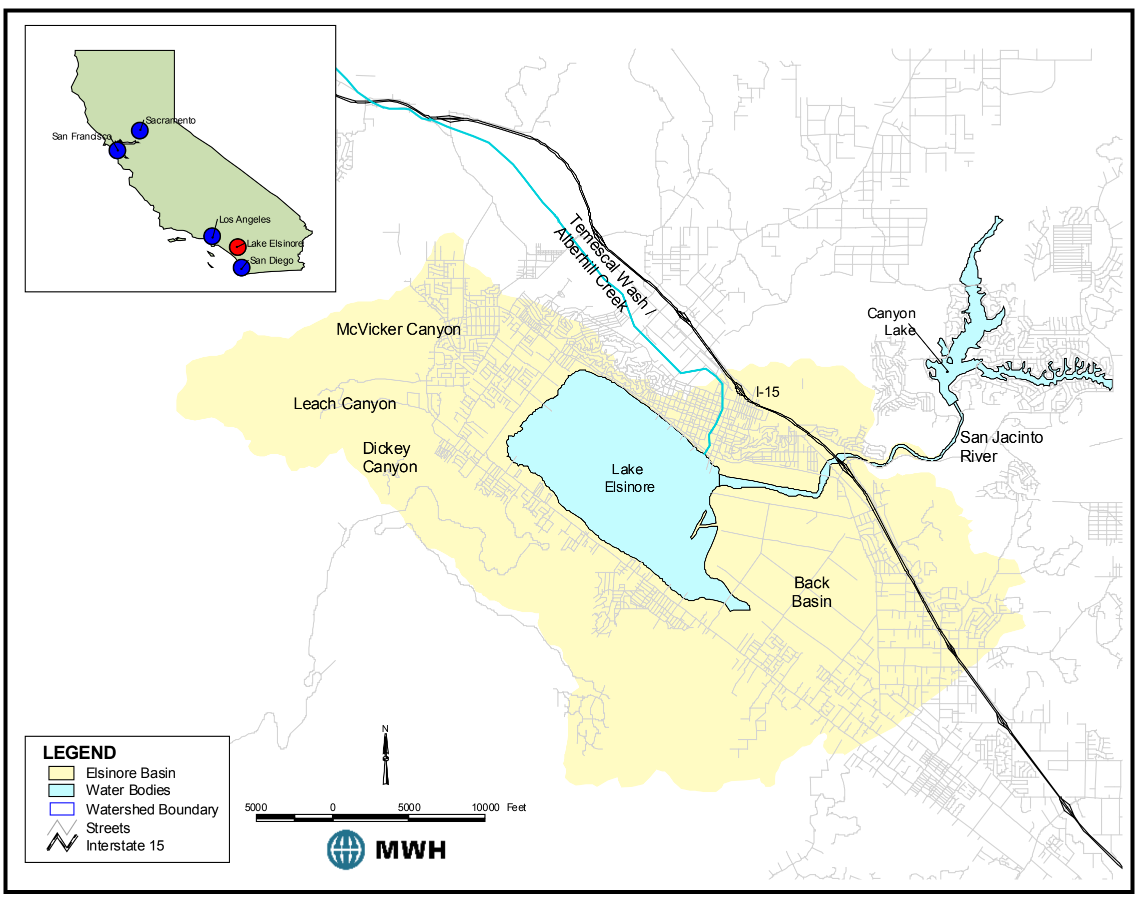
Executive Summary

The objective of this Groundwater Management Plan (GWMP) is to provide an evaluation of the groundwater basin and develop a reliable groundwater supply to meet drought and dry season demands through the year 2020. This plan addresses the hydrogeologic understanding of the basin, the evaluation of baseline conditions, identification of management issues and strategies, and the definition and evaluation of four alternatives. This document concludes with an implementation plan of the recommended alternative, including phasing of projects and capital requirements.

STUDY AREA

The study area is the Elsinore Basin (**Figure ES-1**). The surface drainage area shown on this figure consists of approximately 42 square miles, of which about 25 square miles are located within the basin floor including Lake Elsinore (5 square miles). The remaining portions of the Elsinore Basin include the surrounding highlands and associated streams and canyons. A portion of the area southeast of the lake, referred to as the Back Basin, is part of the flood plain for Lake Elsinore and the San Jacinto River.

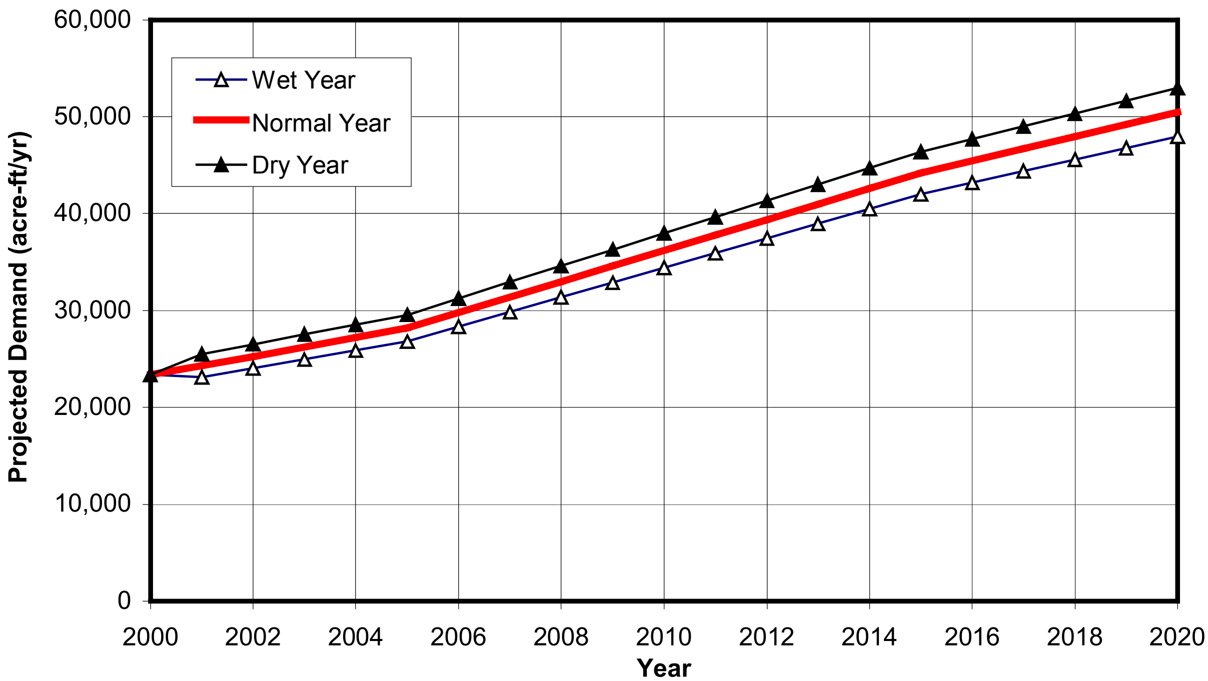
Figure ES-1
Study Area



NEED FOR GROUNDWATER MANAGEMENT PLAN

The work completed as part of this GWMP illustrates that the Elsinore Basin may be in a state of overdraft (about 4,400 acre-ft/yr). A continuation of the current conditions to year 2020 will result in an increased overdraft (about 6,500 acre-ft/yr) and a significant decline in water levels. Water quality degradation and increased risk of land subsidence are two of the related adverse impacts of declining water levels. In addition to these effects, the demand for groundwater will increase in the future due to 1) the need for lake replenishment and 2) additional potable supplies to meet demands over the next 20 years (**Figure ES-2**). The adverse effects of declining water levels combined with increased demands make the development of this GWMP critical. The intent of this plan is to provide a guideline that will resolve the overdraft problem and protect the groundwater supply for use by future generations.

Figure ES-2
Projected Water Demands of EVMWD and EWD



The need and goal statement for this GWMP has been developed through the stakeholder process with local agencies, water purveyors and residents involved in the stakeholder process:

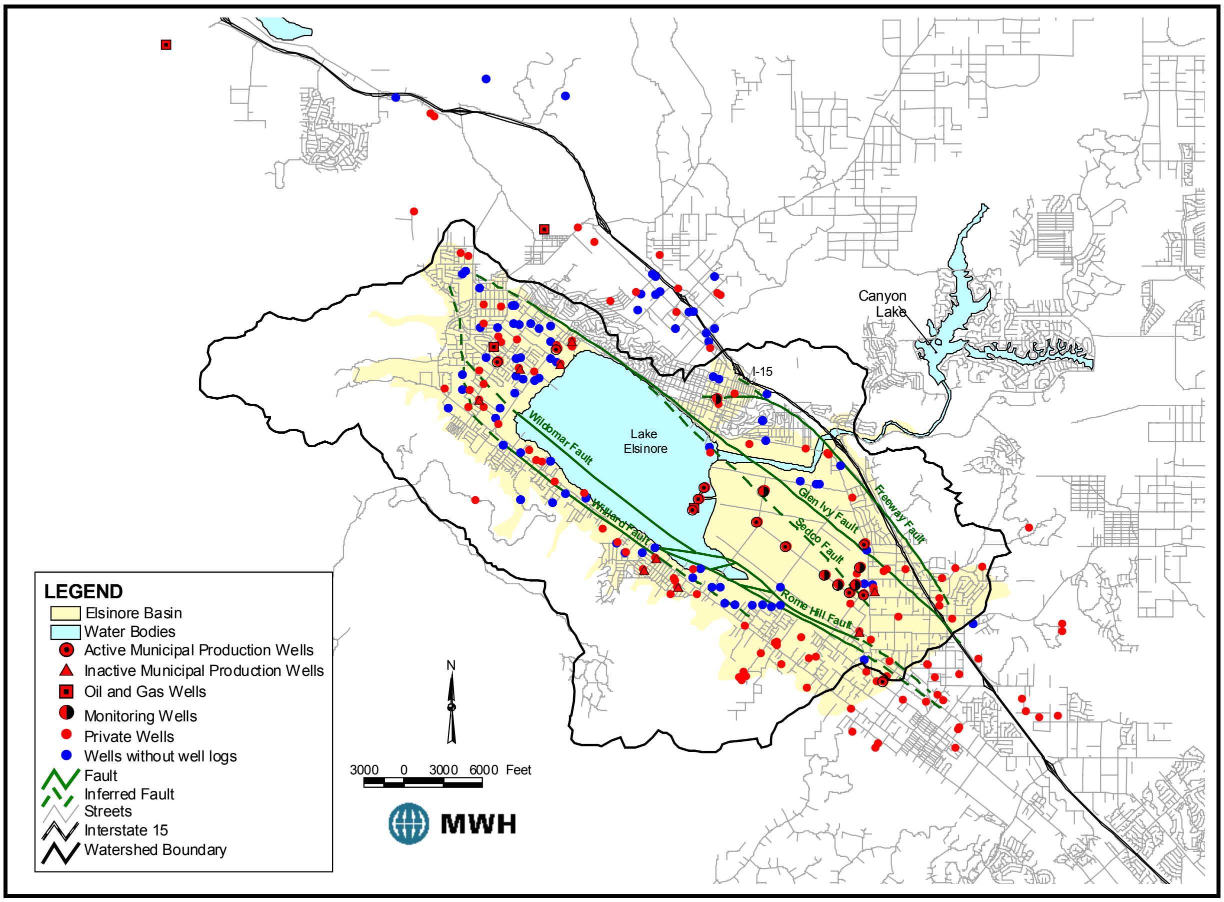
> *"Because water demand is projected to double in the next 20 years, cooperative groundwater management is required to achieve a sustainable water balance in the Elsinore Basin, the goal of this Groundwater Management Plan is to ensure a reliable, high quality, cost-efficient groundwater supply for the users of the Elsinore Basin in an environmentally responsible manner."*

HYDROGEOLOGIC UNDERSTANDING OF THE ELSINORE BASIN

The Elsinore Basin is a major source of water supply for Elsinore Valley Municipal Water District (EVMWD), Elsinore Water District (EWD) and other local groundwater producers. The development of a conceptual understanding of the groundwater basin is an important step in the development of the GWMP and includes the understanding of the geology, fault locations, groundwater flows, groundwater quality and a groundwater budget of the Elsinore Basin.

Figure ES-3 presents the location of the Elsinore Basin, the 239 documented wells, and the location of faults within the Elsinore Basin. There are 151 wells that have well logs, which provide the most comprehensive descriptions of the lithology in the basin.

Figure ES-3
Location of Wells and Faults in the Elsinore Basin



Fault System

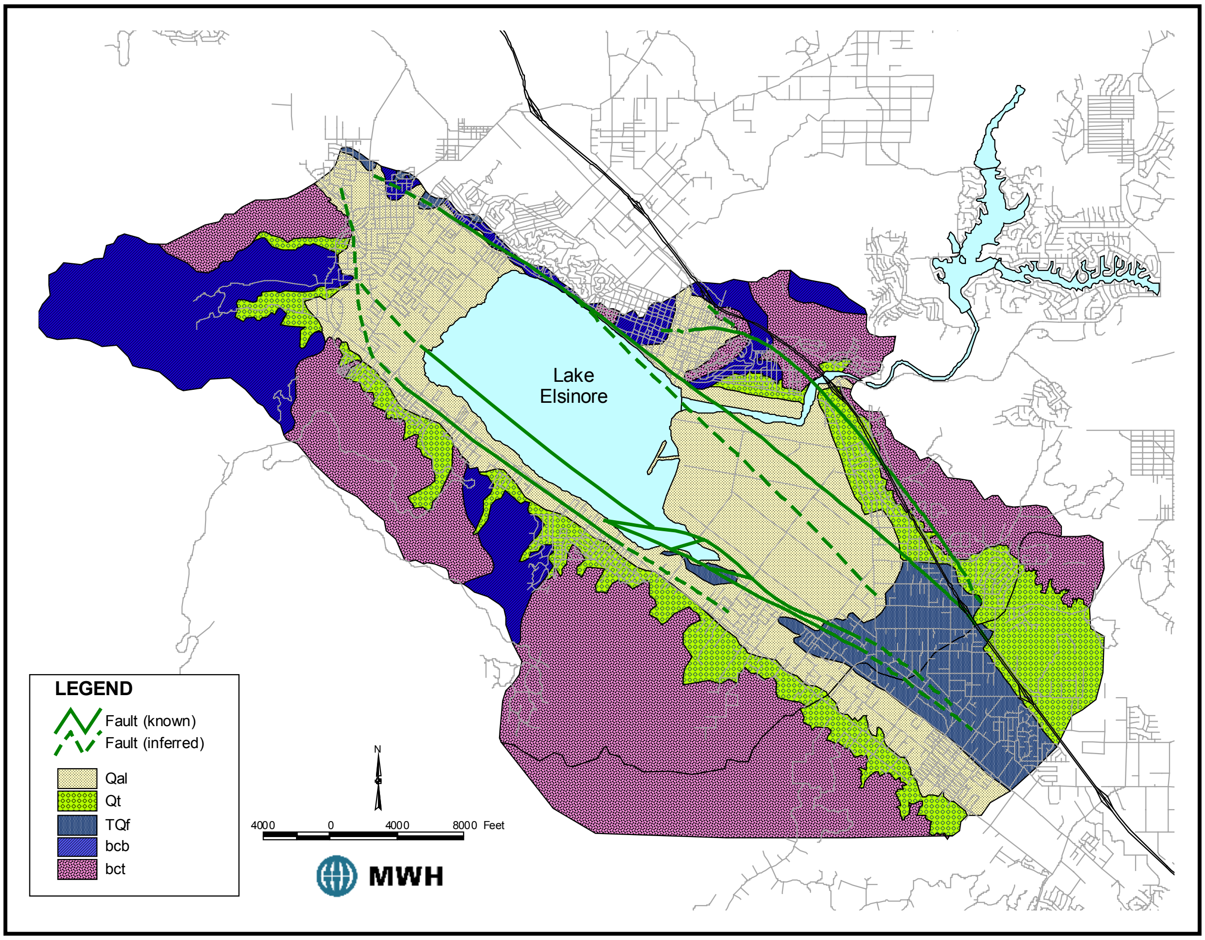
The Elsinore Basin is dominated by two major fault zones, the Glen Ivy Fault Zone which includes the Glen Ivy fault, the Freeway fault and the Sedco fault, and the Wildomar Fault Zone, which includes the Wildomar fault, the Rome Hill fault, and the Willard fault. Of these the Glen Ivy and Rome Hill faults appear to be at least partial barriers to groundwater flow. The Willard and the Wildomar faults do not appear to be barriers to groundwater flow.

Geology

Figure ES-4 shows the geology of the Elsinore Basin, which can be divided into five classifications, also referred to as the hydrostratigraphy of the Basin. These classifications are:

- The Recent alluvium (Qal)
- The Older alluvium (Qt)
- The Fernando Group (TQf)
- The Bedford Canyon Formation (bcb)
- The basement rocks (bct)

Figure ES-4
Geology of the Elsinore Basin



Cross sections are presented in the report that show the relationship between these geologic units. According to the conceptual model developed for this GWMP, the Elsinore Basin is a closed groundwater basin bounded by either bedrock or faults. Inflows to the basin a predominantly from the canyons to the northwest (Leach and McVicker) and the San Jacinto on the northeast. The general groundwater flow direction is from the northwest to the southeast, largely a result of groundwater extraction in the Back Basin.

Groundwater Balance

The groundwater balance prepared for this GWMP covers the period 1990-2001 and consists of the quantification and reconciliation of the following inflow and outflow components:

Inflows

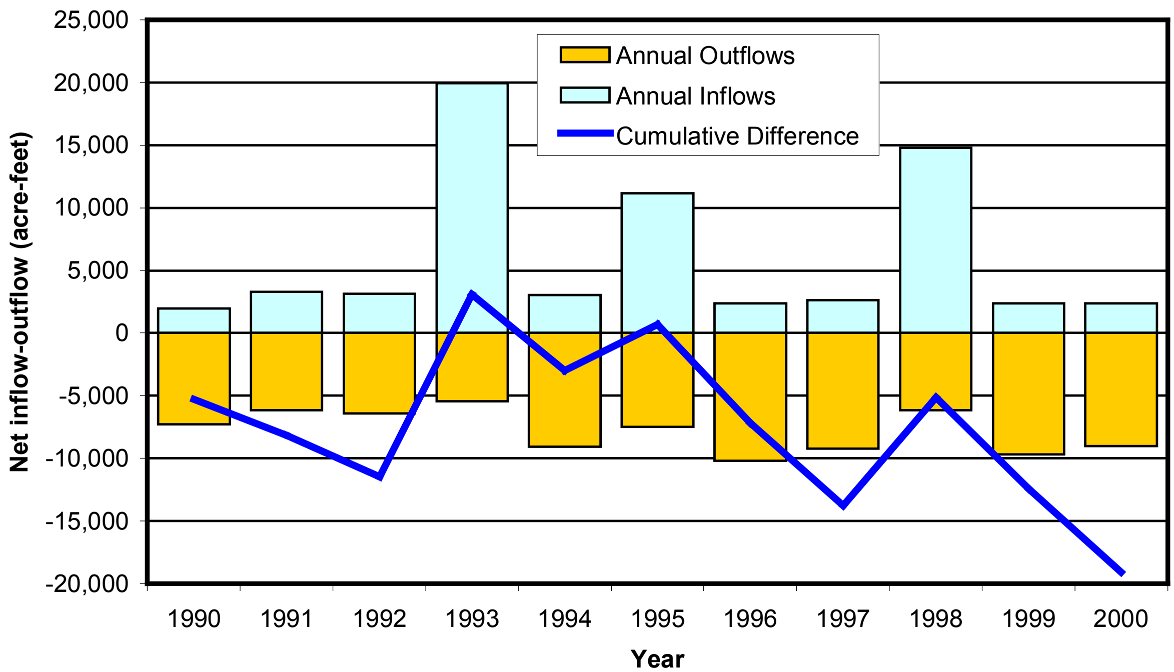
- Infiltration from direct precipitation
- Surface water infiltration
- Infiltration from deep percolation of applied water
- Infiltration from septic tanks
- Underflow into basin

Outflows

- Groundwater pumping
- Flow to surface water
- Underflow out of basin

Based upon this period, the difference between inflows and outflows suggests an average annual groundwater deficit of approximately 1,800 acre-ft/yr over the 11-year period. The estimated cumulative groundwater deficit over the same period was approximately 19,000 acre-ft. **Figure ES-5** shows the estimated annual inflows and outflows over the period, indicating that the Elsinore Basin experienced a groundwater deficit in eight of the 11 years reviewed.

Figure ES-5
Elsinore Basin Groundwater Budget 1990-2001



Water Quality

The water quality of the basin is evaluated based on available data. Although the data shows lateral and vertical variations in water quality, the following general observations can be made:

- Total dissolved solids (TDS) concentrations are generally higher in the area north of Lake Elsinore and along basin margins than in the Back Basin area.
- Highest concentrations of TDS, sulfate and nitrate are found at the Lincoln Street Well.
- Lowest concentrations of TDS and sulfate are found in the Olive Street Well.
- Highest concentrations of nitrate are found in the Palomar Well and these concentrations appear to be increasing.

BASELINE CONDITIONS

The review of historical water conditions indicates that outflows from the Elsinore Basin exceed the inflows. If this condition were to continue in the future, the basin may become overdrafted. To compare the long-term impact of the existing basin operation and the anticipated future operation of the basin, two baseline scenarios (Baselines A and B) are developed. The definition of both baselines is summarized in **Table ES-1**. Baseline B also provides the basis for comparison of the four alternatives developed for this GWMP.

Table ES-1
Summary of Baselines A and B

Baseline A	Baseline B
Year 2000 Demand (average = 25,000 acre-ft/yr)	Year 2020 Demand (average = 50,000 acre-ft/yr)
Year 2000 Land use	Year 2020 Land use
All existing production wells (8)	All existing production wells plus Joy St Well (9)
Canyon Lake WTP at 9 mgd	Canyon Lake WTP at 9 mgd
AVP connection at 24.2 mgd	AVP connection at 24.2 mgd
TVP connection at 12.7 mgd	TVP connection with new PS at 26.5 mgd
No septic tanks conversions	3,000 septic tanks converted to sewer
No Lake make-up	Lake make-up with Island Wells and Recycled Water (7.5 mgd)
No additional new source of supply	Additional new source of supply

Baseline A simulates the current (year 2000) groundwater pumping patterns in the basin, while Baseline B simulates expected pumping conditions in the basin in year 2020 without the implementation of any new groundwater management activities. To evaluate the potential range in groundwater conditions in the basin, the hydrologic conditions for the period October 1960 through September 2001 are used. This 41-year period represents a period of average precipitation and includes a wide range of wet, normal and dry years.

The baseline conditions and the difference in groundwater storage predicted with the groundwater model over the 41-year period are presented in **Figure ES-6** and **Figure ES-7**. As shown in **Figure ES-6**, the basin would experience a storage deficit of about 180,000 acre-ft and 270,000 acre-ft over the 41-year simulation period for Baseline A and Baseline B, respectively.

This corresponds to an average deficit of 4,400 acre-ft/yr for Baseline A and 6,500 acre-ft/yr for Baseline B.

Figure ES-6
Projected Cumulative Groundwater Balance for Baselines A and B

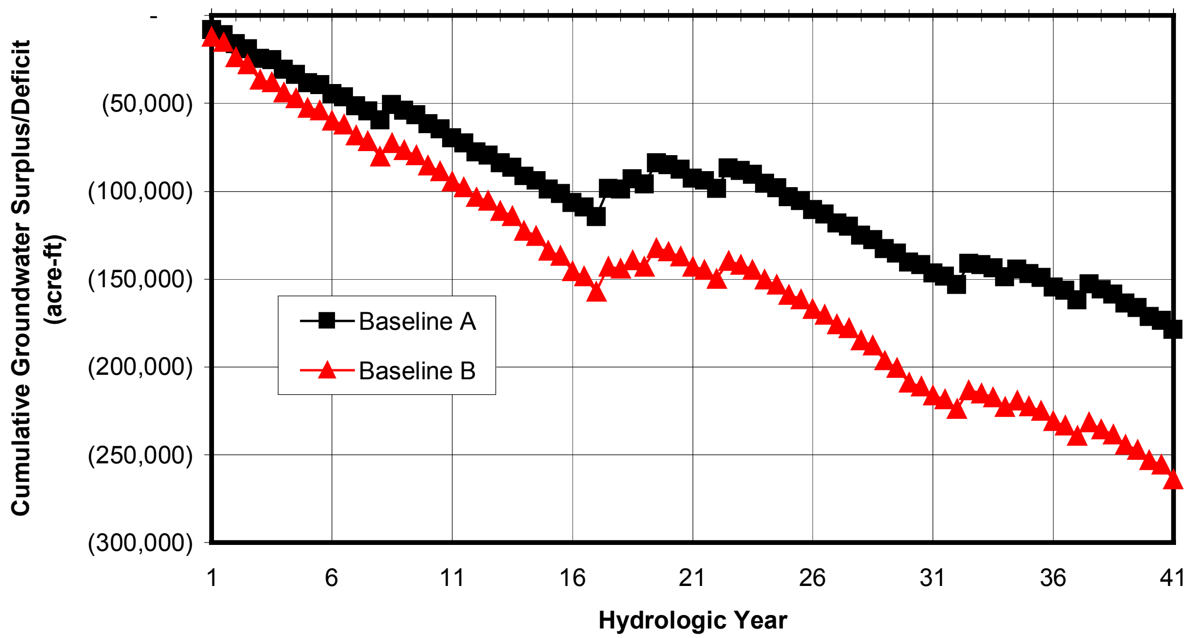
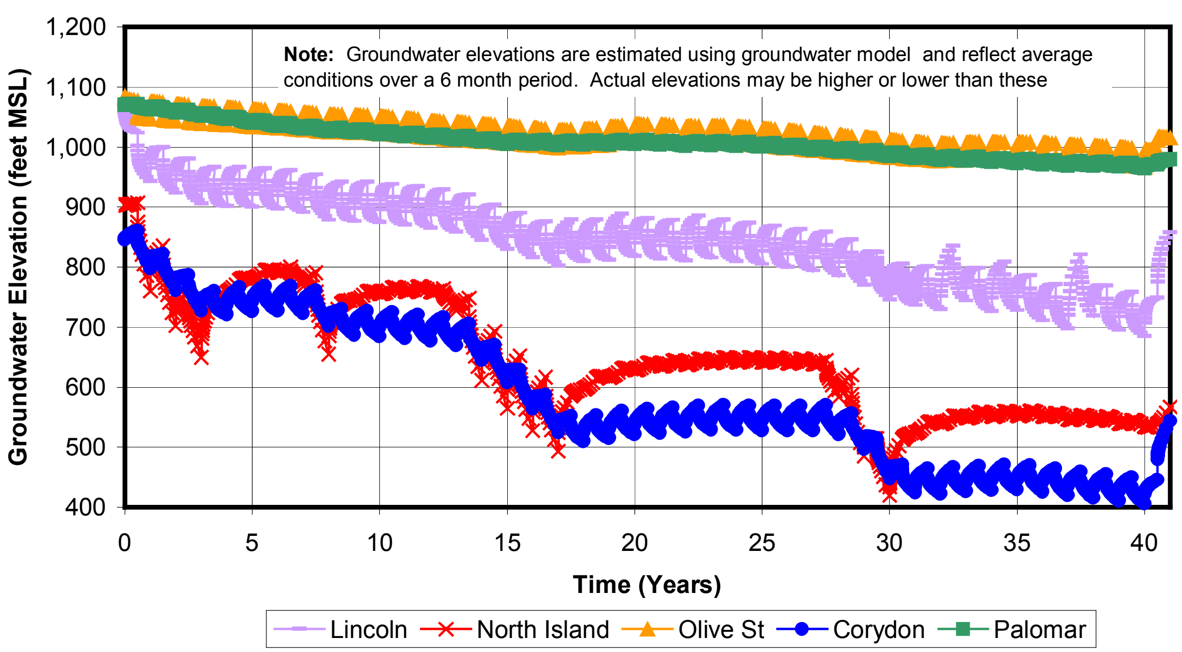


Figure ES-7
Projected Groundwater Levels for Baseline B



As shown in **Figure ES-7**, the water levels are expected to decline throughout the basin. The decrease in water levels is greater under Baseline B conditions than under Baseline A conditions. Under Baseline B conditions, the water levels in the Lincoln Street and Corydon Street wells are projected to drop more than 200 feet and 400 feet over the 41-yr simulation period, respectively. Declining water levels can lead to other detrimental effects such as land subsidence, increased pumping costs, loss of production capacity and water quality degradation.

GROUNDWATER MANAGEMENT ISSUES

This GWMP is prepared in compliance with the Groundwater Management Act, also known as AB3030, which is recently amended by SB1938, which identify twelve specific components and management issues that may be included in a groundwater management plan. These twelve components and five additional potential issues are discussed in detail in **Section 5** and are summarized in **Appendix F**. The following nine main issues pertain to the Elsinore Basin:

- Well head protection
- Groundwater contamination
- Well construction, destruction, and abandonment policies
- Compliance with drinking water regulations and Basin Plan objectives
- Doubling of water demands
- Use of groundwater for Lake Elsinore replenishment needs
- Declining groundwater levels and storage deficit
- Basin monitoring
- Potential of subsidence

GROUNDWATER MANAGEMENT STRATEGIES

A groundwater management strategy is a general approach that addresses one or more of the management issues. The strategies identified in this GWMP are:

- Store imported water by using dual purpose wells
- Increase local supplies by using spreading basins
- Store imported water by using spreading basins
- Store groundwater for dry years by using in-lieu recharge
- Develop new sources of supply
- Reduce supply needs through water conservation
- Measure progress through basin monitoring
- Stakeholder involvement
- Protect groundwater quality by developing programs and policies

These strategies are included in different combinations in the four alternatives that are developed for this GWMP and are compared with Baseline B in the alternative evaluation. Details on these management strategies are presented in **Section 5**.

DESCRIPTION OF ALTERNATIVES

Four alternatives are identified to meet the current and future demands of EVWMD, while achieving a sustainable water balance in the Elsinore Basin. A detailed summary of the components included in the two baselines and the four alternatives is presented in **Table ES-2**. The four alternatives are:

- Alternative 1 – Dual Purpose Wells
- Alternative 2 – Surface Spreading
- Alternative 3 – In-lieu Recharge and Water Conservation
- Alternative 4 – Combination

The average groundwater balance for all four alternatives and the two baselines of the 41-year hydrologic period from 1961 to 2001 is presented in detail in **Section 6** along the water supply balances, and the Lake Elsinore balances. All alternatives are able to meet the year 2020 demands and maintain the Lake level at 1,240 ft MSL by replenishing the Lake with groundwater and recycled water. However, only alternatives 1, 3, and 4 show maintain a balanced groundwater basin (net storage equals zero), while Baseline A, Baseline B and Alternative 2 have an average annual groundwater storage deficit of 4,400 acre-ft, 6,500 acre-ft and 3,800 acre-ft, respectively.

Alternative 1

The purpose of Alternative 1 is to achieve a balanced groundwater basin through a conjunctive use program using the 14 dual-purpose injection-extraction wells. Treated water would be injected during periods when replenishment water is available. The new dual-purpose wells would be used to extract stored groundwater when additional supplies are required to meet the year 2020 demands. The 14 dual-purpose wells are:

- Four conversions of existing deep wells in the Back Basin
- Two new deep dual-purpose wells in the Back Basin
- Five new shallow dual-purpose wells in the Back Basin
- Three new deep dual-purpose wells in the area north of Lake Elsinore.

Injection would take place in 33 of the 41 years and over the 41-year period, an average of 6,700 acre-ft/yr would be injected. Extraction would take place during 22 out of the 41 years. In addition, four peaking wells are required to meet the year 2020 Maximum Day Demands (MDD).

Alternative 2

The purpose of Alternative 2 is to achieve a balanced groundwater basin using spreading basins in Leach and McVicker Canyons to maximize the capture of local runoff water and infiltrate treated imported water. Five new extraction wells would be required in the area north of Lake Elsinore to extract water that is recharged in the spreading basins. Surface recharge would take place every year, ranging from 540 to 6,540 acre-ft in six months.

Table ES-2
Summary of Alternatives

Item	Baseline A	Baseline B	Alternative 1 Dual Purpose Wells	Alternative 2 Surface Spreading	Alternative 3 In-Lieu Recharge and Water Conservation	Alternative 4 Combination
Water Demand	Year 2000	Year 2020	Same as Baseline B	Same as Baseline B	Year 2020 with 10% water conservation	Same as Baseline B with 5% water conservation
Water Supplies	Current Supplies: • 8 Existing EVMWD Wells • 4 Existing EWD Wells • Canyon Lake WTP • AVP Connection • TVP Connection	• Same as in Baseline A • Joy Street Well • 11 wells for peaking	• Same as in Baseline A • Joy Street Well • Conversion of 4 existing wells to dual purpose wells • 10 new dual purpose wells • 4 wells for peaking	• Same as in Baseline A • Joy Street Well • 5 new extraction wells • 11 wells for peaking	• Same as in Baseline A • Joy Street Well • 8 wells for peaking	• Same as in Baseline A • Equipping Joy Street Well as dual purpose • Conversion of 6 existing wells to dual purpose wells • 7 new dual purpose wells • 4 wells for peaking
Land Use	Year 2000	Year 2020	Same as Baseline B	Same as Baseline B	Same as Baseline B	Same as Baseline B
Lake Replenishment	None	• 7.5 mgd of Recycled Water • 3 Island Wells	Same as Baseline B	Same as Baseline B	Same as Baseline B	• 17.7 mgd of Recycled Water • 1 Island Wells
Septic Tanks	Existing Septic Tanks	Existing Septic Tanks	Conversion of all Septic Tanks in the High-Risk Zone	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Special Projects (in addition to the peaking wells)	None	• 17.9 miles of 36-inch to 12-inch diameter pipeline to bring in new source water[2] from the Woodcrest Turnout to Lake St. Tank.	Dual Purpose Wells with imported water: • 3 deep wells north of the lake • 6 deep wells south of the lake[1] • 5 shallow wells south of the lake Other Facilities: • 30-inch diameter pipeline (4,000 ft) • 800 HP pumping station between Cal Oaks and the Back Basin	Surface Spreading with imported water: • 25-acre spreading basin in Leach Canyon • 15-acre spreading basin in McVicker Canyon • 5 extraction wells north of Lake • Pipelines and PS to convey add'l water source to spreading basins	• 8 peaking wells	Dual Purpose Wells with imported water: • 3 deep wells n/o the lake[3] • 6 deep wells s/o of the lake[1] • 5 shallow wells south of the lake Other Facilities: • 30-inch diam. pipeline (4,000 ft) • 800 HP pumping station betw. Cal Oaks and the Back Basin
Basin Monitoring	• Water Quality • Groundwater levels • Groundwater production • Lake levels • Surface flow rates • Rainfall	Same as Baseline A	• Expanded monitoring network for parameters of Baseline A and B • Subsidence	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Stakeholder Involvement	None	None	• Formation of a basin advisory committee	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Wellhead Protection	Existing EVMWD Wells	Same as Baseline A	• Expansion to all active wells in the basin	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Well Construction and Abandonment Program	None	None	• Identification of location/status of wells through a well canvass • Development of a Well Construction and Abandonment Program that includes the coordinates of these activities with Riverside County Department of Environmental Health. • Implementation of policies and regulations	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Land Development Plans	None	None	• Coordination with local and regional planning agencies	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1

Extraction would take place during 22 years of the 41-year period and ranges from 0 to 1,930 acre-ft in six months. In addition, 11 extra wells are required to provide peaking capacity to meet the year 2020 MDD.

Alternative 3

The purpose of Alternative 3 is to achieve a balanced groundwater basin using a combination of in-lieu recharge and water conservation. With in-lieu recharge, the amount of imported water used would be maximized to reduce groundwater pumping, hence increasing the basin storage as natural inflows continue. Construction of new facilities is not required for in-lieu recharge, with the exception of the eight new peaking wells that are needed to meet the year 2020 MDD.

Alternative 4

The purpose of Alternative 4 is to achieve a balanced groundwater basin using a combination of dual-purpose wells, in-lieu recharge, and water conservation. The following 14 dual-purpose wells would be installed for this alternative:

- Four conversions of existing deep wells in the Back Basin
- Two new deep dual-purpose wells in the Back Basin
- Five new shallow dual-purpose wells in the Back Basin
- Equipping Joy Street Well as dual-purpose
- Two new deep dual-purpose wells in the area north of Lake Elsinore

During the 41-year hydrologic cycle, about 240,000 acre-ft of imported water would be injected. Lake replenishment from groundwater is insignificant, because more recycled water is used under this alternative (up to 17.7 mgd versus 7.5 mgd in alternatives 1 through 3). In addition, four peaking wells are required to meet the year 2020 MDD.

EVALUATION OF ALTERNATIVES

The process of evaluating the effectiveness of each alternative in meeting the GWMP's goal involves technical analyses coupled with professional judgment and experience. Each management alternative is evaluated using the following eleven criteria:

- Ability to reduce overdraft
- Expected cost
- Environmental impacts
- Risk
- Legal and regulatory implementation
- Public acceptability
- Funding
- Reliability
- Water Quality
- Flexibility
- Ease of implementation

Alternatives are rated on a scale of 1 to 5, with 5 being excellent and 1 being a very poor score. In addition, each criterion has a weighting factor ranging from 1 to 3, with 3 used for the most important criteria and 1 for the least important criteria. A detailed explanation of each criterion and its ranking is provided in **Section 7**. The evaluation and ranking of Baseline B and

Alternatives 1 through 4 is presented in **Table ES-3**. The ability to reduce overdraft and the costs are explained in more detail below, while the other criteria are discussed further in **Section 7**.

Ability to Reduce Overdraft

The ability to reduce overdraft is evaluated using the groundwater model. The groundwater levels in Baseline B drop between 100 and 400 feet over the 41-year simulation period depending on the location in the Elsinore Basin. In general, groundwater levels decline more in the Back Basin than in the area north of Lake Elsinore. A comparison graph of the North Island Well, which is located in the center of the Elsinore Basin, is presented in **Figure ES-8**.

As shown in this graph, the water levels in Alternative 2 are only slightly higher than the water levels in Baseline B, with declining water levels of about 300 to 350 feet. The declining water levels in indicate that surface spreading alone is not sufficient to achieve a sustainable groundwater balance and make Alternative 2 the worst alternative. Alternatives 1, 3, and 4 are fairly similar with respect to water levels, although Alternatives 1 and 4 show slightly higher water levels than Alternative 3. This is difference indicates the positive effect of the dual-purpose wells in the Back Basin and shows that in-lieu recharge is not as effective in the south part of the basin as in the north part of the basin due to the lack of natural recharge.

Figure ES-8
Comparison Chart for the North Island Well

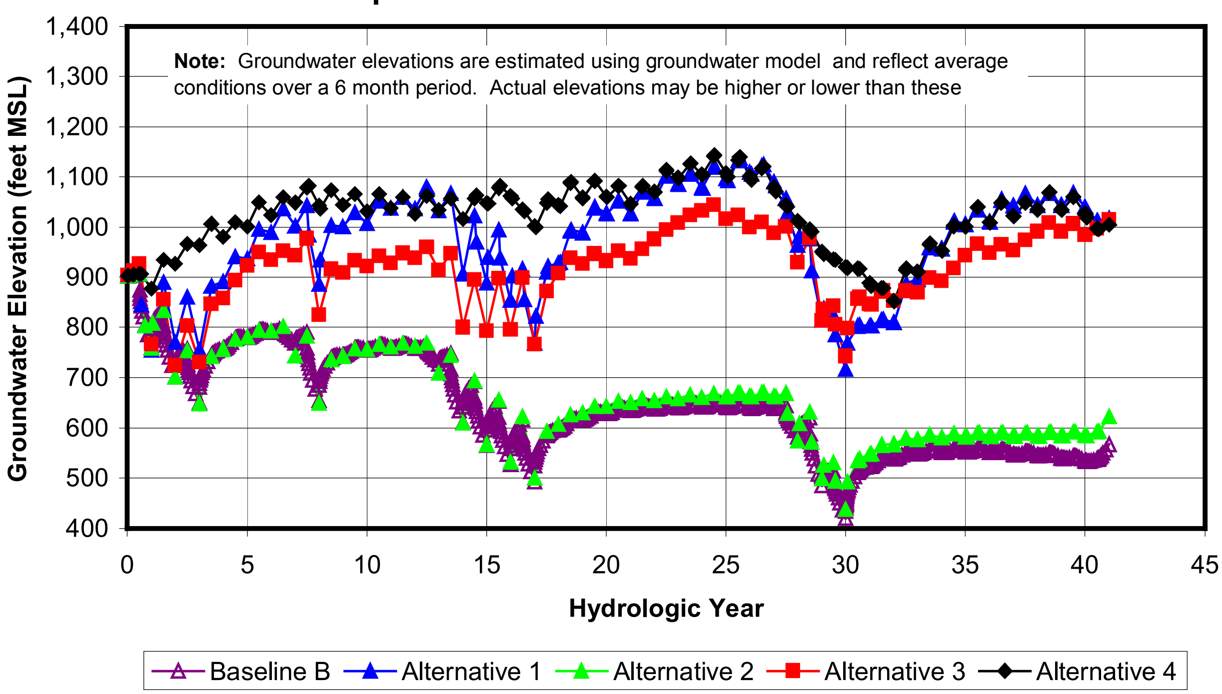


Table ES-3
Summary of Alternatives Evaluation

Evaluation Criteria	Baseline B	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Ability to Reduce Overdraft	1 • Groundwater balance is not achieved. • Zero artificial recharge. • Declining water levels to 400 ft. • Storage Deficit = 6,500 acre-ft/yr.	4 • Groundwater balance is achieved. • 6,700 acre-ft/yr injected. • 600 acre-ft/yr in-lieu recharge. • Stable water levels. • Storage Deficit = 0 acre-ft/yr.	2 • Groundwater balance is not achieved. • 4,800 acre-ft/yr surface spreading. • Declining water levels to 400 ft. • Storage Deficit = 3,800 acre-ft/yr.	3 • Groundwater balance is achieved. • 7,200 acre-ft/yr in-lieu recharge. • Stable water levels. • Storage Deficit = 200 acre-ft/yr.	5 • Groundwater balance is achieved. • 5,900 acre-ft/yr injected. • 600 acre-ft/yr in-lieu recharge. • Slightly increasing water levels. • Storage Deficit = 0 acre-ft/yr.
Expected Costs	4 • $428/acre-ft • $365/acre-ft (without common cost)	3 • $446/acre-ft • $438/acre-ft (without common cost)	3 • $457/acre-ft • $480/acre-ft (without common cost)	5 • $409/acre-ft • $288/acre-ft (without common cost)	4 • $425/acre-ft • $353/acre-ft (without common cost)
Environmental Impacts	1 • Steep declining water levels cause subsidence, which can not be mitigated. • Increase energy usage due to increased pumping lift.	4 • No significant environmental impact other than the construction of wells, pipelines and a PS. • Elimination of overdraft conditions is an environmental benefit.	2 • Use of canyons for spreading basins (30 acres) is likely to cause habitat losses, which may need mitigation. • Overdraft conditions remain, this can not be mitigated.	4 • No negative environmental impact as facilities other than the constructing of peaking wells. • Elimination of overdraft conditions is an environmental benefit. • Water Conservation	5 • No significant environmental impact other than the constructing of wells, pipelines and a PS. • Elimination of overdraft conditions is an environmental benefit. • Water Conservation • Better use of water resources by eliminating groundwater use for lake replenishment
Risk	2 • High risk that wells production will decrease due to declining water levels (resulting in higher cost for additional supplies and decreased reliability). • Moderate risk that additional imported supplies may not be available.	4 • Low risk with injection/extraction technology. • Low risk that the injection capacities are lower than estimated at the time of this GWMP. • Moderate risk that additional imported supplies may not be available.	1 • High risk that surface spreading is not feasible to the extend included in this alternative due to limitations in infiltration (depth to bedrock). • Pilot testing required to determine infiltration rates. • Moderate risk that additional imported supplies may not be available.	3 • Moderate risk that 10 percent water conservation is not achieved. • Moderate risk that additional imported supplies may not be available.	4 • Low risk with injection/extraction technology. • Low risk that the injection capacities are lower than estimated at the time of this GWMP. • Moderate risk that additional imported supplies may not be available.
Legal and Regulatory Issues	2 • Declining water levels are a potential for litigation and may require adjudication of the Elsinore Basin. This causes complex legal and regulatory issues.	3 • Construction permits. • Compliance with 40 CFR Part 144, only water that meets drinking water standards can used for injection. • Development/implementation of septic tank conversion policies required. • NPDES permit required for discharge of 7.5 mgd of recycled water in Lake Elsinore. • Meet Basin Plan objectives.	3 • Construction permits. • Development/implementation of septic tank conversion policies required. • NPDES permit required for discharge of 7.5 mgd of recycled water in Lake Elsinore. • Meet Basin Plan objectives. • Use of recycled water for spreading, is limited to 50 % of the total spreading amount or RO treatment is required.	4 • Construction permits. • Development/implementation of septic tank conversion policies required. • NPDES permit required for discharge of 7.5 mgd of recycled water in Lake Elsinore.	2 • Construction permits. • Compliance with 40 CFR Part 144, only water that meets drinking water standards can used for injection. • Development/implementation of septic tank conversion policies required. • NPDES permit required for discharge of 17.7 mgd of recycled water in Lake Elsinore. • Meet Basin Plan objectives.
Public Acceptability	1 • Public is expected to vigorously oppose to unacceptable subsidence.	5 • Public is expected to support most components.	2 • The public is expected to oppose to some degree of subsidence. • The public may oppose to the construction of spreading basins in the canyons. • Public may oppose to use of recycled water for surface spreading.	3 • Public is expected to support most components of the alternative, however, 10 percent water conservation places a burden on public participation. • The alternative requires minimal construction.	4 • Public is expected to support most components.

Table ES-3 (Continued)
Summary of Alternatives Evaluation

Evaluation Criteria	Baseline B	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Funding	1 • Capital Cost $56 million. • Fair distribution of investments.	3 • Capital Cost $30 million. • Uneven distribution of investments.	1 • Capital Cost $57 million. • Fair distribution of investments.	4 • Capital Cost $16 million. • Even distribution of investments.	4 • Capital Cost $24 million. • Fair distribution of investments.
Reliability	3 • 73% of water supply from MWD in consecutive drought years.	3 • 70% of water supply from MWDSC in consecutive drought years.	3 • 70% of water supply from MWDSC in consecutive drought years.	2 • 84% of water supply from MWDSC in consecutive drought years.	4 • 67% of water supply from MWDSC in consecutive drought years.
Water Quality	1 • Upper aquifer: significant increase in TDS concentration • Lower aquifer: increase in TDS concentration	3 • Upper aquifer: no change in TDS concentration • Lower aquifer: increase in TDS concentration	2 • Upper aquifer: significant increase in TDS concentration • Lower aquifer: no change in TDS concentration	3 • Upper aquifer: slight increase in TDS concentration • Lower aquifer: slight increase in TDS concentration	3 • Upper aquifer: no change in TDS concentration • Lower aquifer: increase in TDS concentration
Flexibility	2 • Projects can be implemented in the future if well production declines or subsidence occurs. However, flexibility to adjust to unforeseen circumstances is low as the need for additional supplies increases the longer projects are postponed.	5 • Dual purpose wells provide flexibility to inject/extract more water depending on demands/availability of MWDSC water. • Flexible to use multiple sources, water from Mills WTP, Skinner WTP, and Canyon Lake WTP. • Not flexible to use multiple water sources as injected water needs to comply with Title 22.	3 • Flexible to use multiple water sources for spreading; local runoff, treated imported water, untreated imported water, Canyon Lake WTP water, recycled water from the regional WWTP or EMWD. • Limited capacity of spreading basins to maximize use of replenishment water.	3 • Flexible to adjust to higher demands (lower water conservation) than anticipated with GW pumping. • Poor flexibility to implement new projects, as the need for additional supplies increases the longer projects are postponed. • Moderate flexibility to use replenishment water for in-lieu recharge as this amount is limited by (winter) water demands.	5 • Dual purpose wells provide flexibility to inject/extract more water depending on the availability of MWDSC water. • Flexible to use multiple sources, water from Mills WTP, Skinner WTP, and Canyon Lake WTP. • Not flexible to use multiple water sources as injected water needs to comply with Title 22.
Ease of Implementation	3 • Construction required of 11 wells • Substantial re-equipment of wells • Construction of new pipeline for additional source.	4 • Construction required of 13 wells, 1 pipeline and 1 pumping station.	2 • Construction of spreading basins required in canyons, which is expected to be difficult due to rocks, and difficult accessibility of the upper part of leach canyon. • Construction of 17 wells, pipelines and a booster station. • Substantial re-equipment of wells.	3 • No construction required other than 8 wells. • Implementation of water conservation measures that contribute to 10 percent conservation may be difficult.	4 • Construction required of 11 new wells • Conversion of 6 existing wells to dual purpose. • Construction of 1 pipeline and 1 PS • Implementing water conservation. measured that contribute to 5 percent conservation.
Total Rating	**21**	**41**	**25**	**37**	**45 (highest score)**
Weighted Rating	**42**	**81**	**50**	**77**	**92 (highest score)**

Estimated Cost

The estimated capital cost, annual operation and maintenance (O&M) cost, and the annual cost to purchase treated imported water are summarized per alternative in **Table ES-4**. Detailed cost information is presented in **Section 7** and **Appendix H**.

Table ES-4
Cost Summary per Alternative

Item	Baseline B	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Capital Cost	$ 49,970,000	$ 30,020,000	$ 57,380,000	$ 15,760,000	$ 24,310,000
Total Annual Cost (excl. common cost)[1]	$ 4,595,700	$ 5,518,000	$ 6,050,000	$ 3,629,000	$ 4,445,000
Water Supply (acre-ft/yr) (excl. common supplies)[2]	12,600	12,600	12,600	12,600	12,600
Unit Cost ($/acre-ft)	**$ 365**	**$ 438**	**$ 480**	**$ 288**	**$ 353**

1 – Excludes cost of Canyon Lake WTP, Imported water at Tier 1 rate, and Imported water Tier 2 rate as in Baseline B.
1 – Excludes supplies from Canyon Lake WTP (3,000 acre-ft/yr), Tier 1 (13,320 acre-ft/yr), and Tier 2 as in Baseline B (21,580 acre-ft/yr)

As shown in this table, the capital cost range significantly from $16 million to $57 million, and the unit costs range from $288 to $480 per acre-ft. The unit costs presented exclude the cost and supply amounts that are common in all alternatives to emphasize the differences. Common cost and supplies that are excluded from the unit cost calculations are:

- The cost of Canyon Lake WTP water (same amount for all alternatives and Baseline B)
- The cost of imported water at Tier 1 rate (same amount for all alternatives and Baseline B)
- The cost of imported water at Tier 2 rate as required for Baseline B.

As the actual amount of Tier 2 water varies between the alternatives, the incremental cost difference compared to Baseline B is included in the cost estimates. Alternative 3 is the least expensive followed by Alternative 4 and Alternative 1. Although the unit costs of Baseline B and Alternative 2 are fairly similar to the cost of Alternatives 1, 3 and 4, the effect on the groundwater basin is significantly different, as these alternatives do not achieve a sustainable groundwater balance.

Conclusion of Alternative Evaluation

As shown in **Table ES-3**, Alternative 4 scores the highest with and without the weighted ranking. The second best alternative is Alternative 1. Although Alternative 3 has the lowest unit cost, it is ranked third with based on all evaluation criteria. Alternative 2 does not score much higher than Baseline B. Alternative 4 is selected as the preferred alternative because the unit cost are lower than Alternative 1, and because it includes water conservation and maximizes increase use of recycled water for lake replenishment, which are both in-line with the environmental responsibility stated in the District's mission statement.

IMPLEMENTATION PLAN

The preferred alternative, further referred to as the recommended plan, includes water conservation, dual-purpose wells for basin recharge, the use of recycled water as the primary source for lake replenishment, and a basin monitoring program. In addition, the plan contains recommendations for stakeholder involvement through an advisory committee, wellhead protection, well construction and abandonment procedures, the development of septic tank policies, and agency coordination. Each of these components is discussed more detail in **Section 8**. A map depicting the location of the structural components required for the implementation of the recommended plan is presented in **Figure ES-9.**

Conjunctive Use with Dual-Purpose Wells

The recommended plan contains the installation of 14 dual-purpose wells to recharge the groundwater basin during wet periods and provide storage for dry periods. Seven new dual purpose-wells are proposed to be installed in the Back Basin area (2 deep and 5 shallow), while six existing wells (Lincoln, Machado, Cereal 1, Cereal 3, Cereal 4, and Corydon wells) are proposed to be converted to dual-purpose wells. Joy Street Well is also proposed to be equipped as dual-purpose well.

In general, injection would take place between October and March in years when replenishment (Long Term Storage; or, LTS) water is available, which depends on the hydrologic conditions of the sources that contribute to MWDSC's overall supply. Injection may be possible year around during wet years if excess replenishment water is available. The dual-purpose wells would be used for extraction in the summer months of dry years when the demands increase and the available imported supply from MWDSC decreases. The operation of the basin under average rainfall year conditions is presented in **Figure ES-10**. The injection amount presented in purple is slightly higher in wet years and zero in dry years.

In addition to dual-purpose wells, in-lieu recharge at about 1,100 acre-ft/yr of is used recharge the groundwater basin to maintain a sustainable groundwater balance. In-lieu recharge can start immediately, as it does not require any construction, providing that LTS water is available.

Lake Replenishment with Recycled Water

Maintenance of water levels in Lake Elsinore would be accomplished with recycled water and groundwater when the lake level drops below 1,240 feet MSL. Recycled water would be used as the primary source of replenishment water up to 17.7 mgd. This is the projected capacity of the Regional Plant in year 2020 minus 0.5 mgd reserved for discharge to Temescal Wash. One of the three Island Wells would be used as the secondary source when the recycled water supply is not adequate to maintain the lake level, while all three wells are required to maintain lake levels before year 2020 when less recycled water is available. It is recommended that EVMWD investigates the extension of the discharge permit with the Regional Board to enable the proposed use of recycled water in the future. In addition, it is recommended to study the potential of using recycled water from Eastern Municipal Water District for lake replenishment or serving non-potable demands within the District's service area.

Figure ES-9
Components of the Recommended Plan

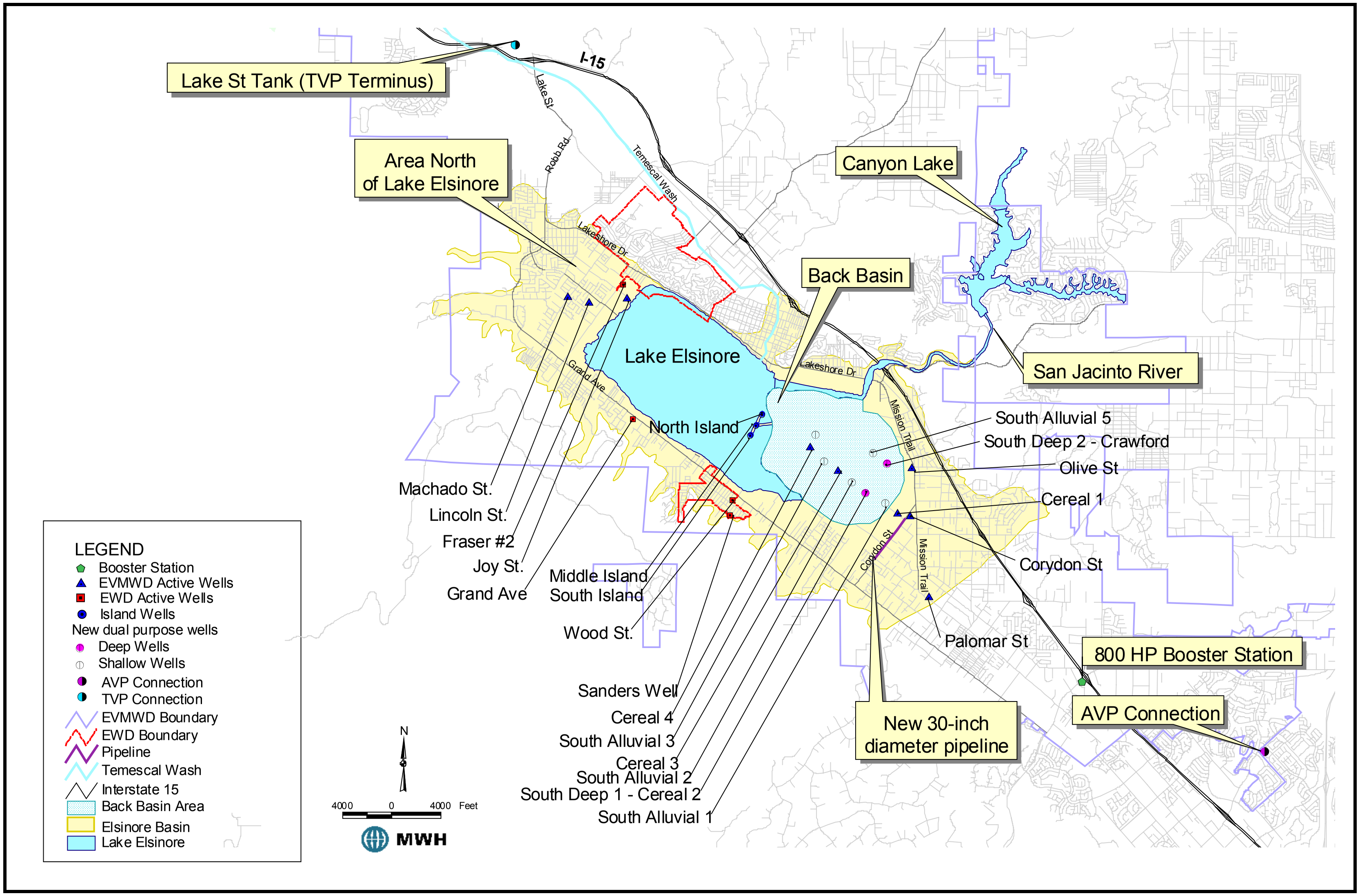
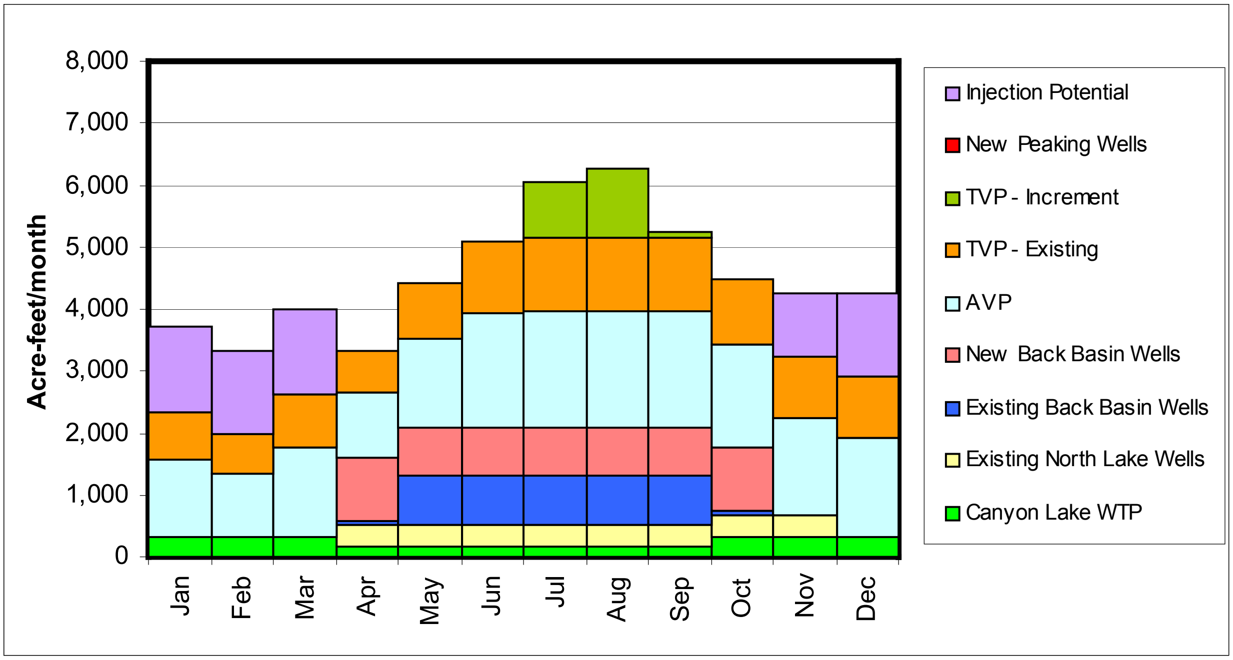


Figure ES-10
Water Supply Mix during an Average Rainfall Year



Basin Monitoring Plan

As part of the GWMP a separate Monitoring Plan is prepared to better understand the groundwater basin and to measure the effects of the activities that are implemented. This monitoring program incorporates the Joint Groundwater Monitoring Program that was established by the May 2000 agreement between EVMWD and EWD. The key components of the proposed monitoring plan are:

- Construction of five new monitoring wells
- Monitor of water levels on a monthly basis.
- Monitor water quality data on an annual basis
- Monitor surface water flows
- Monitor land subsidence
- Conduct a well canvas.
- Conduct spinner logging testing, water quality zone testing, and aquifer testing.

The information collected through this monitoring program will lead to more efficient implementation of management activities, as it would provide guidance for adjusting management parameters according to the results over time.

Advisory Committee

The GWMP recommends that EVMWD's Board of Directors shall appoint five members to form an Advisory Committee that represents the users of the Elsinore Basin. The Advisory Committee could be involved with the following programs and activities and provide their comments on these activities to the EVMWD Board of Directors:

- Implementation of the Groundwater Management Plan
- Final development and coordination of the Monitoring Program
- Development of Well Construction, Destruction, and Abandonment Policies.

Septic Tank Conversion Policies

The recommended plan presumes that, at a minimum all septic tanks in the high-risk zone, as shown in **Figure 5-2**, should be connected to the sewer system by year 2020. Approximately 2,900 septic tanks, which is about 80 percent of all the septic tanks in the basin, are located in this high-risk zone and should be connected to the sewer system, while no additional septic tanks be added within the high-risk zone. The District is currently developing the policies to accomplish the conversion of septic tanks. An economic analysis that quantifies the cost and benefits of septic tank conversions should be considered as part of the policy development.

Cost of Recommended Plan

A detailed cost breakdown of the capital and annual costs for the recommended alternative are presented in **Table ES-5** The total capital cost is $24.3 million, while the total annual cost is about $21.5 million. With a projected water demand of 50,500 acre-ft/yr in year 2020, these total annual costs correspond to a unit cost of $425 per acre-foot. This unit cost includes all the cost that are common to all alternatives for Canyon Lake WTP, Tier 1 water, and Tier 2 water. When these common costs are excluded, the unit cost of the recommended plan is $353 per acre-foot. As explained in the phasing in **Section 8**, the majority of the capital investments are required between the years 2003 and 2010.

CONCLUSIONS

This GWMP has determined that the Elsinore Basin is currently in a state of overdraft, with a cumulative deficit of 19,000 acre-ft/yr over the past 11 years, or approximately 1,800 acre-ft/yr. A detailed evaluation of the baseline conditions for the year 2000 conditions (Baseline A) and the projected year 2020 conditions (Baseline B) predict that this overdraft will increase to an average of 4,300 acre-ft/yr to 6,400 acre-ft/yr, respectively. Based on groundwater model simulations, this GWMP predicts that this storage deficit will result in declining water levels of 200 to 400 feet. These declining water levels may result in significant water quality degradation, land subsidence, or reduced groundwater pumping capacity of existing wells.

Table ES-5
Summary of Estimated Cost of the Recommended Plan

Cost Type	Project Description		Capital Cost	Annual Cost
Capital Cost	4 Peaking Wells		$ 7,480,000	$ 194,000
	Conversion of 6 Existing Wells to Dual Purpose Wells		$ 600,000	$ 37,000
	Equipping Joy Street as a Dual Purpose Well		$ 100,000	$ 7,000
	7 New Dual Purpose Wells		$ 13,090,000	$ 339,000
	30-inch diameter pipeline on Corydon Street (4,000 LF)		$ 1,360,000	$ 50,000
	800 HP in-line PS (near Clinton Keith Rd./I-15)		$ 1,680,000	$ 103,000
	Subtotal		**$ 24,310,000**	**$ 730,000**
O&M Cost	**Quantity (acre-feet/yr)**	**Cost Item**		**Annual Cost**
	8,188	Groundwater Pumping in Back Basin Area		$ 691,000
	2,132	Groundwater Pumping N/O Lake		$ 166,000
	380	Groundwater Pumping EWD		$ 31,000
	0	Groundwater Pumping for Lake Replenishment		$ -
	3,400	Recycled water for Lake Replenishment		$ 510,000
	3,000	Canyon Lake WTP		$ 690,000
	13,320	Purchase of MWD Water (Tier 1)		$ 5,568,000
	19,880	Purchase of MWD Water (Tier 2)		$ 9,921,000
	5,900	Purchase of MWD Water for Injection		$ 1,770,000
	1,100	Purchase of MWD Water for In-Lieu recharge		$ 330,000
	12,000	Pumping Cost in-line PS (near Clinton Keith Rd./I-15)		$ 232,000
	2,500	Water Conservation		$ 650,000
	Subtotal			**$ 20,559,000**
Total				**$ 21,472,000**

This document contains recommendations for activities to better manage the groundwater resources of the Elsinore Basin. The requirements stated in AB3030 and the amended by SB1938 have been used for the identification of groundwater management issues and to be in compliance with the Groundwater Management Act. The proposed recommendations are to provide solutions to the basin management challenges. Some key issues are:

- An increase need for groundwater due to lake replenishment needs and a doubling of water demand between 2000 and 2020.
- Significant existing and projected groundwater level declines imposing the risk of water quality degradation and land subsidence
- An increasing trend in nitrate concentrations in areas with septic tanks and a projected increase of TDS concentrations.
- Potential for water quality contamination through the over 200 wells in the basin with an unidentified well status.

Some of the key recommendations presented in this GWMP are:

- Development of an Advisory Committee to continue the Stakeholder involvement process and to help the EVMWD Board of Directors effectively manage the basin.
- Implementation of conjunctive use projects to achieve a sustainable groundwater balance and ensure a reliable water supply.
- Implement a water conservation program to reduce potable water demands by five percent.
- Minimize the use of groundwater for lake replenishment and save the high quality groundwater to serve potable demands
- Expand the monitoring program to enhance the understanding of the groundwater basin and to help manage future conjunctive use operations.
- Develop septic tanks conversion policies and well construction and abandonment policies to protect the basins water quality.

The basin management proposed in this GWMP will initiate a proactive approach to groundwater management in the Elsinore Basin and allow the Elsinore Valley to grow and double its demands over the next 20 years, while maintaining a reliable, affordable, and sustainable water supply.

Section 1
Introduction

The Groundwater Management Act (California Water Code Part 2.75, §10753), originally enacted as Assembly Bill (AB) 3030 (1992) and amended by Senate Bill (SB) 1938 (2002), provides the authority to prepare groundwater management plans. The intent of AB3030 is to encourage local agencies to work cooperatively to manage groundwater resources within their jurisdictions. The Elsinore Basin Groundwater Management Plan (GWMP) is jointly funded under a Local Groundwater Management Assistance Act of 2000 (AB303) grant by the California Department of Water Resources (DWR) and the Elsinore Valley Municipal Water District (EVMWD) in accordance with Contract Number 4600001817 dated June 25, 2001. This GWMP provides the framework for the management of groundwater resources in the Elsinore Basin and is the guidance document for future groundwater development activities.

The lead agency for this plan is EVMWD. This plan has been prepared in coordination with local agencies, water purveyors and interested residents through a stakeholder involvement process facilitated by DWR. The GWMP is intended to provide a better understanding of the Elsinore Basin and to recommend various management strategies that result in a reliable water supply for all users of the Elsinore Basin while meeting the increasing water demands.

The following section provides an introduction to the GWMP. It includes a description of the study area, the current state of the groundwater supply in the basin, project objectives and a summary of the remainder of the report.

SCOPE OF WORK

This GWMP is prepared with the assistance of Montgomery Watson Harza (MWH) and funded by a grant from the State of California administered by DWR under AB303. The scope of work funded by the State includes the following six technical tasks.

- Data assessment
- Stakeholder involvement
- Preparation of a groundwater monitoring program
- Update of conceptual hydrogeologic model
- Preparation of numerical groundwater model
- Preparation of the GWMP

The work conducted for these tasks is presented in the remainder of this report. References used in the preparation of this report are listed in **Appendix A**. A list of abbreviations is provided in **Appendix B**.

STUDY AREA

The study area for this plan is the Elsinore Basin as shown in **Figure 1-1**. The surface drainage area shown on this figure consists of approximately 42 square miles, of which about 25 square

Figure 1-1
Study Area

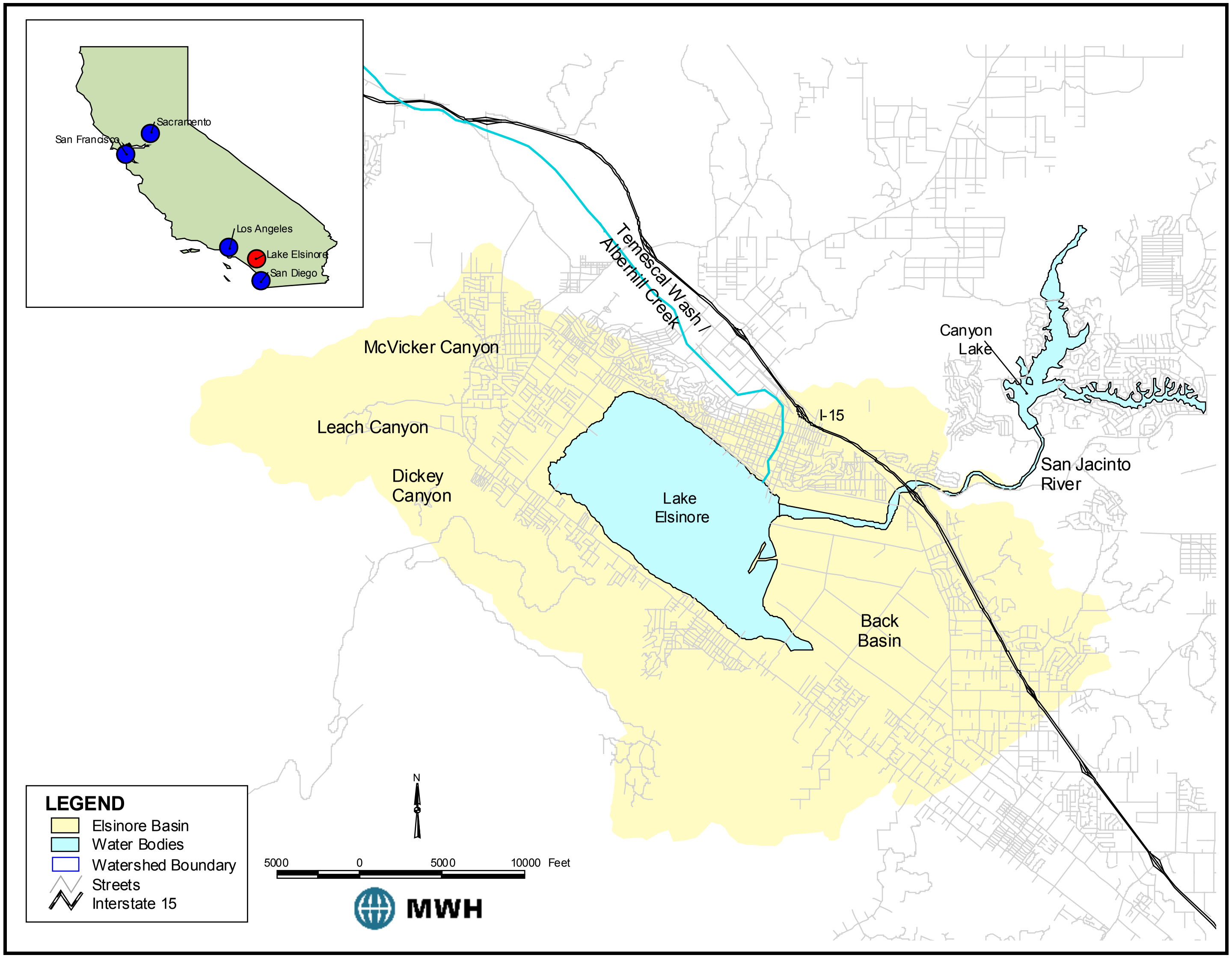
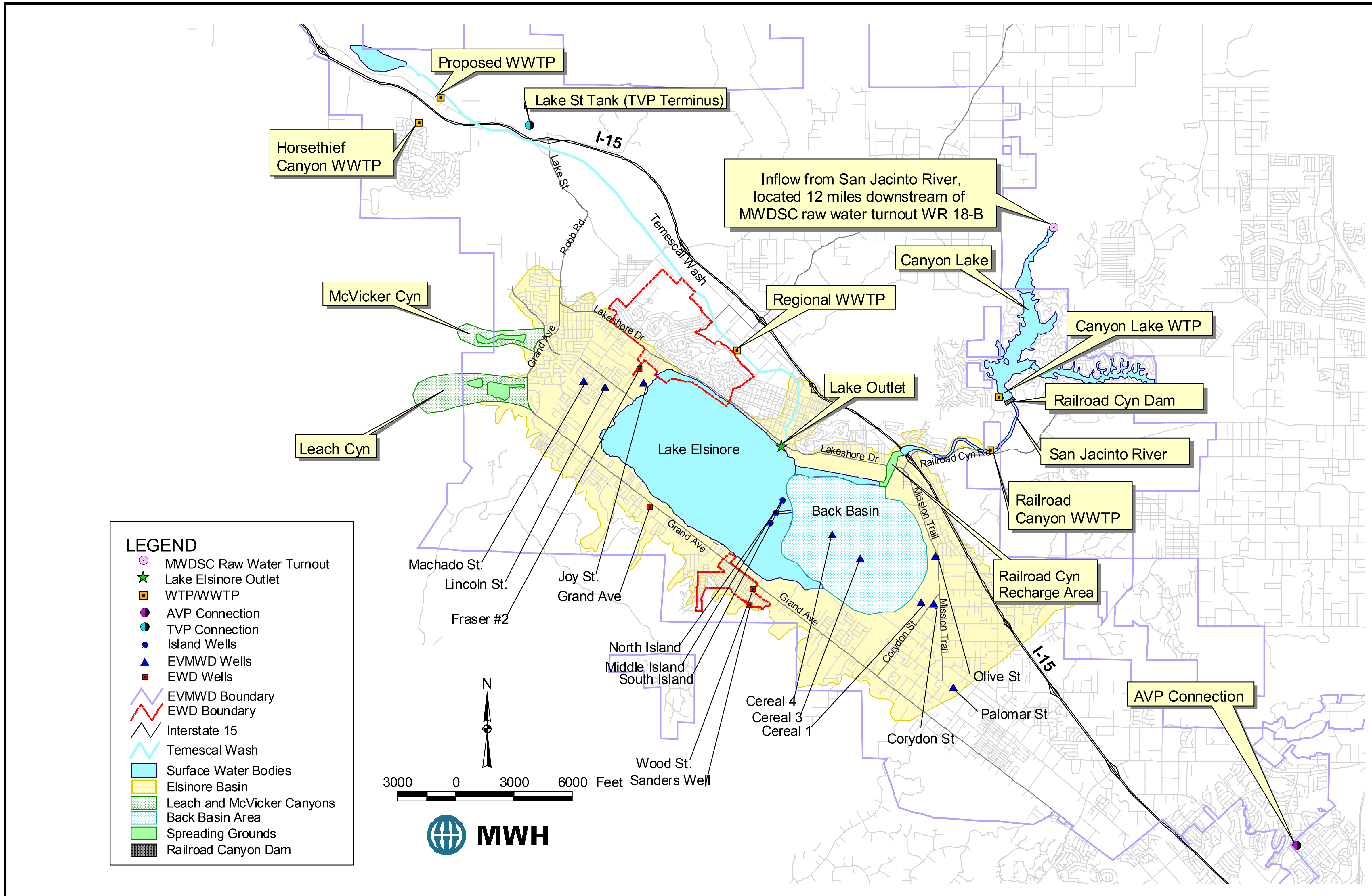


Figure 1-2
Locations of Key Facilities in the Elsinore Basin



miles are located within the basin floor including Lake Elsinore. The remaining portions of the Elsinore Basin include the surrounding highlands and associated streams and canyons. In general, the surface water in the study area drains toward Lake Elsinore. Principal surface water streams and rivers include McVicker Canyon, Leach Canyon and Dickey Canyon along the western margin of Lake Elsinore and the San Jacinto River from the east. During periods of high lake levels, water in Lake Elsinore flows into the lake outlet channel, which discharges to Temescal Wash, which flows to the Santa Ana River. The area southeast of the lake, referred to as the Back Basin, is part of the flood plain for Lake Elsinore and the San Jacinto River. The boundary of the groundwater basin is approximately coincident with the surface drainage boundary shown on **Figure 1-1**.

PROJECT BACKGROUND

The EVMWD provides water service to a 96 square mile area in western Riverside County. In the Elsinore Basin, the EVMWD currently obtains its water supply from eight groundwater wells, the Canyon Lake Water Treatment Plant (WTP) and the Metropolitan Water District (MWDSC) of Southern California (through Western Municipal Water District) to meet the water demands of its customers. The EVMWD's service area and the location of the water supplies are presented in **Figure 1-2**. EVMWD is the primary groundwater producer in the Elsinore Basin. EVMWD currently pumps approximately 94 percent of the groundwater produced in the Elsinore Basin. Elsinore Water District (EWD), whose service area includes portions north of Lake Elsinore and Lakeland Village south of Lake Elsinore, pumps approximately 5 percent of the groundwater supply. Local pumpers with private wells account for about 1 percent of the pumping in the basin.

Based upon previous studies prepared by the EVMWD, including the Urban Water Management Plan (MWH, 2000), the Water Resources Development Plan (MWH, 1997), and the Distribution System Master Plan (MWH, 2002), rapid growth in the Elsinore area is expected over the next 10 to 20 years. Demands within the Elsinore Basin (including EVMWD's service area and EWD's service area) are projected to more than double by 2020 (from about 23,400 acre-ft/yr in 2000 to as much as 53,100 acre-ft/yr in 2020). EWD's demand is not projected to increase during this time period, as its service area is largely built-out. In the Water Resources Development Plan (MWH, 1997), 26 water supply alternatives were evaluated with various supply sources. This report identified water supplied by the State Water Project (SWP) as the preferred water source. In the Distribution System Master Plan (2002), a supply deficit was projected but future sources were not identified. Because the Distribution System Master Plan contains the most recent water demand projections, these data are used in this GWMP as a basis for supply needs for EVMWD.

To meet the current and future water demands, EVMWD will be increasingly dependent on imported water supplies. For example, in 2000, the groundwater wells accounted for 34 percent of the annual water demand with an additional 10 percent supplied from the Canyon Lake WTP. The remaining 56 percent was imported water supplied by Metropolitan through the Auld Valley Pipeline (AVP) connection. Based upon the Distribution System Master Plan, by 2020, as much as 80 percent of the demand is projected to be supplied by imported water from either the Temescal Valley Pipeline (TVP) or the AVP. Because groundwater is an important part of the future water supply picture, prudent management of the Elsinore Basin is critical.

PROJECT OBJECTIVES

The goal of the GWMP is based upon the assessment of the management issues for the Elsinore Basin and the mission statement of EVMWD. The mission statement of EVMWD is:

> *"To manage the District's natural resources to provide reliable, cost efficient, high quality water and wastewater services for the communities we serve, while promoting conservation, environmental responsibility, education, community interaction, ethical behavior, and recognizing employees as highly valuable assets."*

Based upon discussion with local agencies, water purveyors and residents involved in the stakeholder process, the following statement defines the need and goal for the GWMP:

> *"Because water demand is projected to double in the next 20 years, cooperative groundwater management is required to achieve a sustainable water balance in the Elsinore Basin. The goal of this Groundwater Management Plan is to ensure a reliable, high quality, cost-efficient groundwater supply for the users of the Elsinore Basin in an environmentally responsible manner."*

The purpose of the GWMP is to serve as the guidance document for implementation of groundwater projects required to meet the plan objectives. The following four plan objectives are defined to achieve this goal:

- Enhance water supply reliability
- Manage the basin yield
- Maintain suitable water quality
- Improve understanding of basin hydrogeology

The primary objective of the GWMP is to enhance the water supply reliability through conjunctive use activities in the Elsinore Basin. Conjunctive use is the process of storing water in the groundwater basin during periods in which additional water supplies are available, while extracting the water in periods of low water supplies typical as a result of droughts. Water can be stored through direct injection, surface spreading or in-lieu storage activities.

The second objective of the GWMP is to manage the basin yield. The GWMP includes a compilation of data needed to estimate the basin yield and define measures required for a sustainable operation of the Elsinore Basin.

The third objective is to maintain suitable water quality in the Elsinore Basin. The quality of water in the Elsinore Basin is generally good. However, there are groundwater quality concerns in various locations throughout the basin. For example, contamination from septic tanks, the risk of increased concentrations of organic compounds as development progresses in the Elsinore area, and elevated arsenic concentrations are known water quality issues that need to be considered in the recommended management strategies. This GWMP includes water quality management recommendations. These management activities address the current basin conditions as well as the future conditions after implementation of the plan. The water quality evaluation guidelines defined under the AB3030 process will be followed where applicable to the Elsinore Basin.

The fourth objective is to improve the current understanding of the basin hydrogeologic characteristics. A thorough understanding of the basin is critical to the development of future groundwater management projects in the basin. Previous studies have developed a significant understanding of the basin but more work is needed to best manage this important resource.

REGIONAL SETTING OF ELSINORE BASIN

Because many management issues are related to the complex interaction between water bodies and demands within the Elsinore Basin, an understanding of these interactions is important to developing a management plan for the basin. The principal water bodies, demands and discharges are:

- The Elsinore Basin watershed and groundwater basin
- Surface water bodies (Lake Elsinore, Canyon Lake, Temescal Wash, and the San Jacinto River)
- Water supply sources (groundwater, Canyon Lake WTP, imported water, recycled water local runoff)
- Demands (potable, non-potable, evapotranspiration)
- Water disposal (wastewater, outflows to surface water bodies)

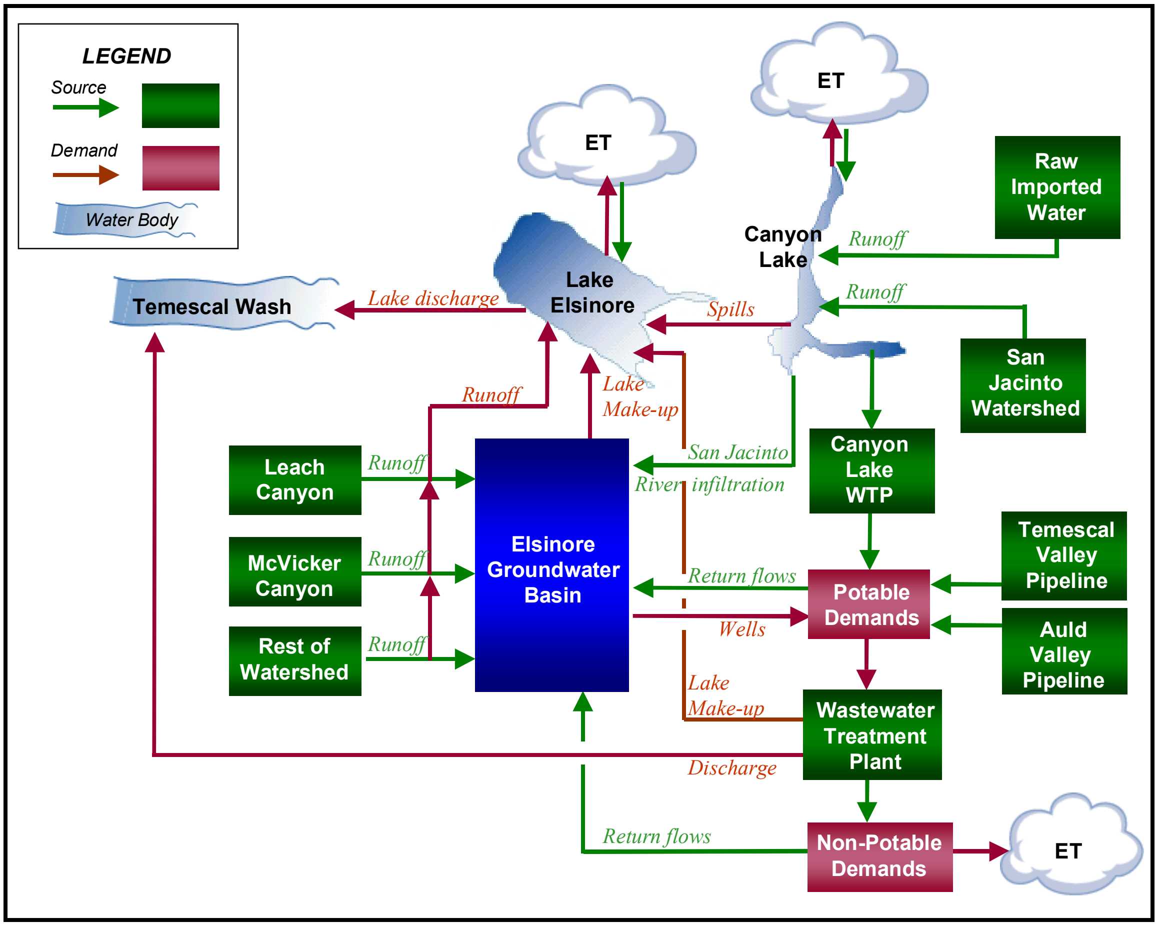
The locations of these features are provided in **Figure 1-2**. The relationships between the water bodies and water users are shown in **Figure 1-3**.

To define management alternatives that achieve a sustainable water balance, the interactions of all the water bodies shown in Figure 1-3 need to be evaluated. Each component is discussed in detail below.

Elsinore Groundwater Basin

The principal source of inflow to the Elsinore groundwater basin is infiltration of local precipitation and runoff from the surrounding watershed (an average of nearly 40 percent of the total inflows). Other inflows to the groundwater basin are water that infiltrates from the San Jacinto River prior to reaching Lake Elsinore and return flows from either irrigation or domestic use. Currently, the only significant outflow from the groundwater basin is the groundwater pumping to meet potable water demand. To maintain the water level in Lake Elsinore above the desired operating level of 1,240 feet above mean sea level (MSL), EVMWD is equipping the three Island wells to pump groundwater into the Lake when the Lake levels are low. In addition, the Elsinore Basin is essentially closed to subsurface inflows and outflows from adjacent groundwater basins as well as Lake Elsinore. The only exception to this is future pumping of groundwater to maintain lake levels, as discussed below.

Figure 1-3
Water Flows in the Elsinore Basin



Lake Elsinore

Lake Elsinore is a natural lake that, under historical conditions, has varied in size from 6,000 acres in very wet years to a dry playa in drought years. To moderate these swings in lake surface area and to reduce evaporation, a levee was constructed across the lake in 1995, which reduced its surface area from approximately 6,000 to about 3,300 acres. Operational details for Lake Elsinore are provided in **Table 1-1**.

Table 1-1
Operational Data for Lake Elsinore

Location	Level
Target lake elevation	1,240 feet MSL
Normal Lake operating range	1,240 – 1,249 feet MSL
Elevation of sill in the outlet channel	1,255 feet MSL
Elevation of emergency outlet to the Back Basin	1,262 feet MSL
Elevation of 100-year floodplain	1,263.3 feet MSL

Inflows to Lake Elsinore include local runoff from the surrounding watershed, precipitation directly onto Lake Elsinore, flows from the San Jacinto River, recycled water from wastewater treatment plants and, in the near future, groundwater from the Island wells. Outflows include overflows to Temescal Wash, which occur when the lake level exceeds 1,255 feet MSL and evaporation. Less than 15 percent of the total runoff from the watershed flows into the lake on an annual average basis. The local runoff that reaches the lake accounts for only about eight percent of the annual lake inflow. This amount varies from year to year, ranging from about 1,500 acre-ft/yr in dry years to more than 5,600 acre-ft/yr during wet years. Approximately 20 percent of the inflow to Lake Elsinore comes from precipitation directly onto the lake. The remaining 72 percent of the inflows to the lake come from the San Jacinto River.

In addition to the existing inflows from the San Jacinto River and local runoff, Lake Elsinore will soon be replenished with groundwater from the Island wells to maintain a minimum lake level of 1,240 feet MSL. Likewise, as much as 2 mgd of recycled water from the Regional Wastewater Treatment Plant (WWTP) is currently discharged to the lake under a two-year pilot study.

The major water loss from the lake is evaporation that ranges between 13,000 and 15,000 acre-ft/year depending on the lake level and climate conditions. When the lake level exceeds the sill elevation in the outflow channel of 1,255 feet, water is discharged to the Temescal Wash. During major storm events, when the lake level reaches an elevation of 1,262, water will spill to the area south of the dike, also referred to as the Back Basin. Most of the water that is spilled to the Back Basin is lost to evapotranspiration; only a minimal portion will infiltrate into the groundwater basin because of the presence of substantial clay layers near the surface.

Canyon Lake

Canyon Lake receives water from the San Jacinto River watershed and, occasionally, untreated imported water from a connection to MWDSC's Colorado River Aqueduct. Canyon Lake is maintained between 1,372 and 1,382 feet MSL and spills into Railroad Canyon at an elevation above 1,382 feet MSL. Approximately ninety percent of these spills reach the Lake. When water is available, Canyon Lake water is treated in the Canyon Lake WTP. This plant typically operates between April and October to provide additional water for summer demands. Additional untreated Colorado River water can be purchased from the WR-18B turnout to supplement Canyon Lake flowing down the San Jacinto River.

Imported Water Supplies

EVMWD can purchase imported water at three locations, the TVP connection, the AVP connection, and Colorado River Aqueduct turnout WR-18b. Water obtained through the TVP is SWP water that originates from MWDSC's Mills Filtration Plant. Water from this plant is conveyed through the Woodcrest Pipeline up to the Woodcrest Turnout (near I-15) where the TVP connects, which conveys water to the northwestern part of the District's distribution system. Water obtained through the AVP connection is a blend of SWP and Colorado River Aqueduct water that is treated at MWDSC's Skinner Filtration Plant. EVMWD can also obtain untreated imported water from the MWDSC's WR-18B connection to the Colorado River

Aqueduct, which discharges into the San Jacinto River 12 miles north of Canyon Lake. The untreated imported water flows down the San Jacinto River until it reaches Canyon Lake.

Wastewater and Recycled Water

In the areas served by sewers, wastewater is collected and treated at one of the three wastewater treatment plants (Regional WWTP, Railroad Canyon WWTP, or Horsethief Canyon WWTP). Wastewater effluent from the Regional WWTP is discharged into the Temescal Wash and is used for lake replenishment as part of a pilot test program. Effluent from the Railroad Canyon and Horsethief Canyon WWTPs is used for local golf course and landscape irrigation.

Potable Demands

Potable water demands are met from four supply sources: imported water from the AVP and the TVP, groundwater, and surface water from the Canyon Lake WTP. After use, a portion of the water is either returned to the groundwater basin as irrigation returns, septic tank effluent, or wastewater flowing to the Regional WWTP.

Non-Potable Demands

Non-potable demands include lake replenishment for Lake Elsinore. As discussed above, additional water is required to maintain the level of Lake Elsinore above 1240 feet MSL. Current non-potable supplies include up to 7.5 mgd of recycled water from the Regional WWTP (8 mgd capacity less 0.5 mgd for Temescal Wash) and up to 5.2 mgd from the Island wells.

Summary

This conceptual understanding of the Elsinore Basin will be used to develop the groundwater model and the alternatives and to provide the framework for implementation of the GWMP. EVMWD is committed to developing a GWMP that takes into consideration the complex water supply interactions within the Elsinore Basin. The remainder of this report provides documentation of the development process and action items for implementation of the GWMP.

REPORT OVERVIEW

The Elsinore Basin GWMP is divided into the following eight sections:

- **Section 1** is the introduction of the GWMP
- **Section 2** includes a description of the hydrogeologic setting of the Elsinore Basin and a description of the conceptual model.
- **Section 3** describes the development of a numerical groundwater model for the Elsinore Basin
- **Section 4** describes existing and future baseline conditions
- **Section 5** includes a discussion of management issues
- **Section 6** describes the management alternatives
- **Section 7** evaluates each management alternative and recommends the preferred alternative
- **Section 8** provides an implementation plan for the recommended alternative

Section 2
Hydrogeologic Setting

The Elsinore Basin is a major source of water supply for EVMWD, EWD and other local groundwater producers. The development of a detailed understanding of the groundwater basin is an important step in the development of the GWMP. The following section discusses the development of the hydrogeologic conceptual model for the Elsinore Basin. This section includes a summary of:

- previous work and data collection efforts
- geology and structure
- groundwater flow
- groundwater quality and
- a preliminary groundwater budget

BACKGROUND

Previous Work

In 1994, Geoscience Support Services Inc. (Geoscience) under contract with EVMWD provided a comprehensive review of the hydrogeology of the Elsinore Basin. The Geoscience report compiled historical information from previous reports including: State Water Resources Control Board (1953 and 1959), Harding-Lawson Associates (1978 and 1980) and DWR (DWR, 1981). The purpose of the report was to define the Elsinore Basin in sufficient detail to evaluate the feasibility of surface recharge and injection facilities to augment groundwater supplies. Geoscience prepared a hydrogeologic conceptual model based upon available data at that time, evaluated geophysical data, prepared a numerical groundwater model and evaluated the economic feasibility of recharge in the Elsinore Basin. MWH updated the information compiled in the Geoscience report based upon subsequent efforts and recent information gathered as part of this project.

Neblett and Associates (1998 and 1999) performed a detailed geologic study to evaluate the feasibility of the Liberty Development, a proposed 878-acre residential and golf course development in the Back Basin area. This effort included a fault study and geotechnical study including an extensive field program. The field program included: 21,000 lineal feet of seismic refraction lines, sixty-five cone penetrometer soundings, sixty-one hollow stem auger borings, and forty-six groundwater piezometers to depths of 110 feet. In addition, this report provided an aerial photographic lineament analysis to identify the location of the Glen Ivy fault, a seismic analysis and a liquefaction study to evaluate the feasibility of residential development in this area. The study also defined the surface trace of the Glen Ivy fault. According the Neblett and Associates (1998), the fault zone is "complex and a single main trace was not discernable" and ranges from approximately 100 feet to 500 feet wide.

Data Collection

A variety of additional data has been collected as part of the GWMP effort. A thorough review of the available hydrogeologic data is a prerequisite for the development of the conceptual model. In addition, the data collected under this task served as the input data for the numerical groundwater flow model developed for this groundwater management plan. As part of the GWMP development, data has been compiled to evaluate the characteristics of the Elsinore Basin, define the watershed, calculate the water budget, and identify potential surface recharge locations. The information types are categorized as follows:

- Reference reports
- Base maps
- Boundary maps
- Well information
- Water levels
- Production records
- Surface water flows
- Precipitation data
- Water quality data
- Geophysical data

Data Organization

The collected data are organized in a Geographic Information System (GIS) format. A GIS is a combination of a database program and a graphical interface that displays the information on geographic maps. A GIS gives the user the ability to organize and analyze information geographically. By compiling the information in a groundwater GIS, information can be accessed more easily and information can be combined and presented spatially to obtain a better understanding of the groundwater basin. The groundwater GIS for the GWMP is developed using *ArcView 3.2,* a product of the Environmental Systems Research Institute (ESRI). The GIS is used for the following purposes in the Elsinore Basin:

- Data collection and organization
- Geographic mapping
- Information analyses
- Calculations
- Provide input data for the numerical model

The groundwater GIS is created in the NAD83, Zone V, California coordinate system. All information added in the future should be in this coordinate system to obtain the same geographic projection of information.

Data Sources

The sources of the information collected are presented by data type in **Table 2-1** along with the file format. The shapefile format is the generic file format for the GIS. Other file formats that are compatible with ArcView include images (tiff and pdf), AutoCAD drawings (dwg and dxf), and database tables (dbf and xls).

Table 2-1
Data Sources

Data Type	Data Description	Data Source	Data Format
Base maps	Parcels Streets and Freeways Aerial Photography Water Bodies Ground Elevation Contours	EVMWD EVMWD EVMWD EVMWD USGS[1]	Shapefile Shapefile Shapefile Shapefile Shapefile
Boundary maps	EMD – EVMWD Service Areas Groundwater Basins San Jacinto Watershed Townships, Ranges & Sections Elsinore Basin Watershed	EVMWD EVMWD EVMWD EVMWD MWH[1]	Shapefile Shapefile Shapefile Shapefile Shapefile
Well information	Various	Various	Shapefile
Groundwater levels	Monthly Data 1919-2001[3]	EVMWD	Spreadsheet
Production records	Monthly Data 1947-2000[3]	EVMWD, SAWPA, SWRCB[4]	Spreadsheet
Stream gauge data	Daily Data 1916-2001	USGS	Spreadsheet
Precipitation data	Monthly Data 1897-2001	RCFCD [5]	Spreadsheet
Water quality data	Monthly Data 1985-2001[3]	Monitoring Wells[2], DHS[6]	Spreadsheet
Geophysical data	Geologic Formations Faults Seismic Lines	MWH[7,] CDMG (1969) [8] MWH[7,] CDMG (1969) [8] GeoScience (1994), Neblett &Associates (1999	Shapefile Shapefile Shapefile

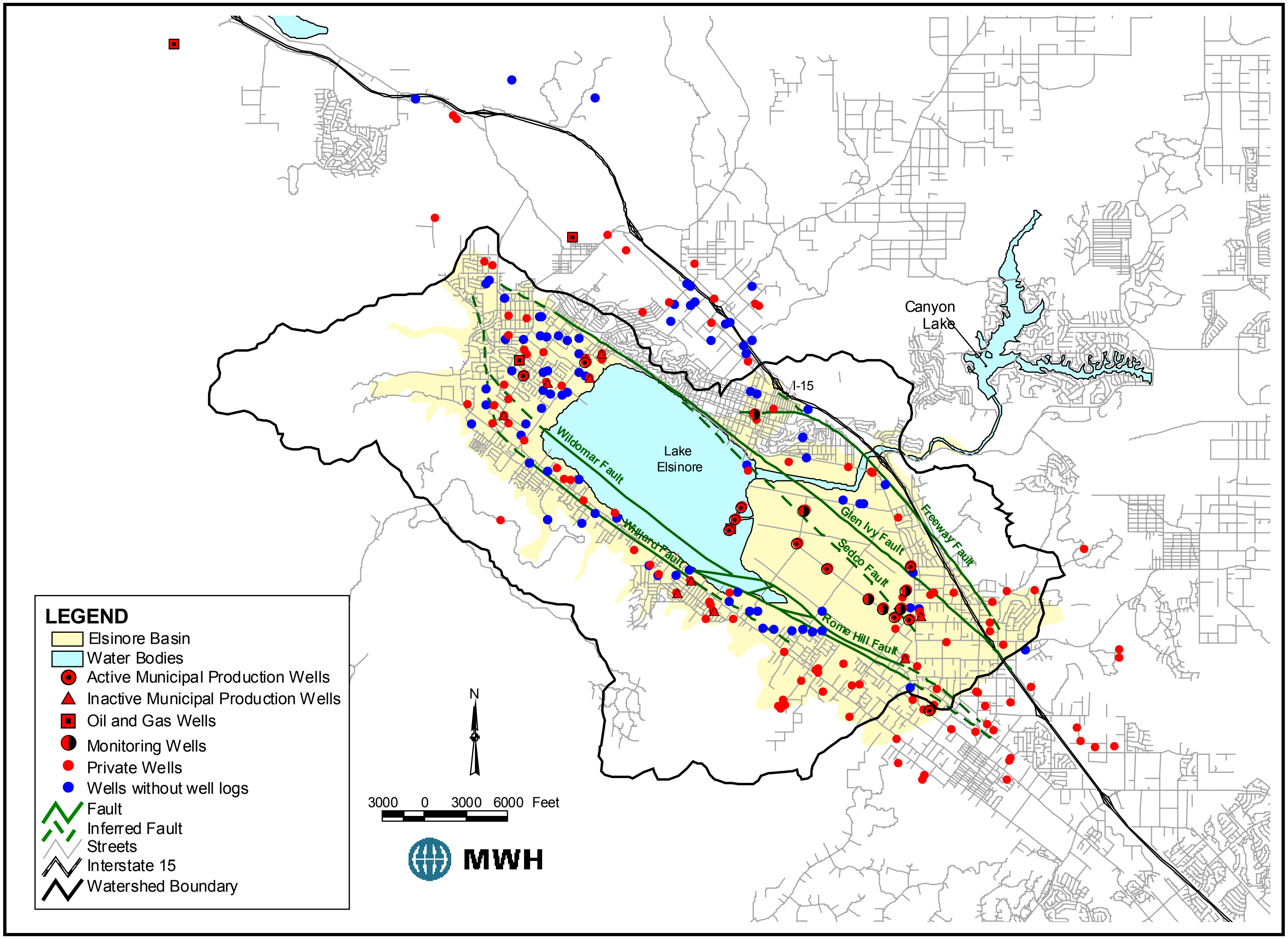
1 – Drawn and digitized from United States Geological Survey (USGS) contour data
2 – Newly drilled monitoring wells added by MWH
3 – Sporadic data
4 – State Water Resources Control Board
5 – Riverside County Flood Control District
6 – Department of Health Services
7 – Interpretation of various reports in combination with Back Basin pilot testing results
8 – California Division of Mines and Geology

Spreadsheet data including historical water levels, production records and water quality data are not included in the GIS because this format is more flexible for many types of analyses.

Well Information

Lithologic data from wells are critical to the development of the conceptual hydrogeologic model for the Elsinore Basin. **Figure 2-1** presents the location of 239 documented wells within the Elsinore Basin. The location of faults, seismic lines, precipitation stations and stream gauges are also included for reference. The wells are color-coded based on the availability of well logs.

Figure 2-1
Wells in the Elsinore Basin



There are 151 wells that have well logs, which provide the most comprehensive descriptions of the lithology in the basin, and are colored red. Well logs are not available for the remaining 88 wells, which are colored blue. The level of information per well log varies greatly – 23 well logs provided limited information and are not used in the subsequent analysis. A total of 124 well logs are scanned and are saved electronically in .pdf format. Based upon the well log data, tops and bottoms of the principal aquifer units are documented and compiled. These data are used to define the structure of the basin as discussed later in this section.

Data Assessment

Based upon a review of the well information and other data, EVMWD has elected not to perform a seismic reflection survey to evaluate the geologic structure in the basin as initially envisioned for this project. The seismic studies previously conducted throughout the basin (i.e. Harding Lawson, 1978 and 1980; Neblett & Associates, 1998), provide sufficient seismic data to define the overall structure of the basin. Therefore, EVMWD has installed one new monitoring well in McVicker Canyon and plans to install an additional monitoring well in lieu of the seismic reflection survey outlined in Subtask I-4.1. The additional monitoring wells provide actual lithologic data that can be used to confirm the conclusions drawn from the previous seismic work.

GEOLOGY AND STRUCTURE

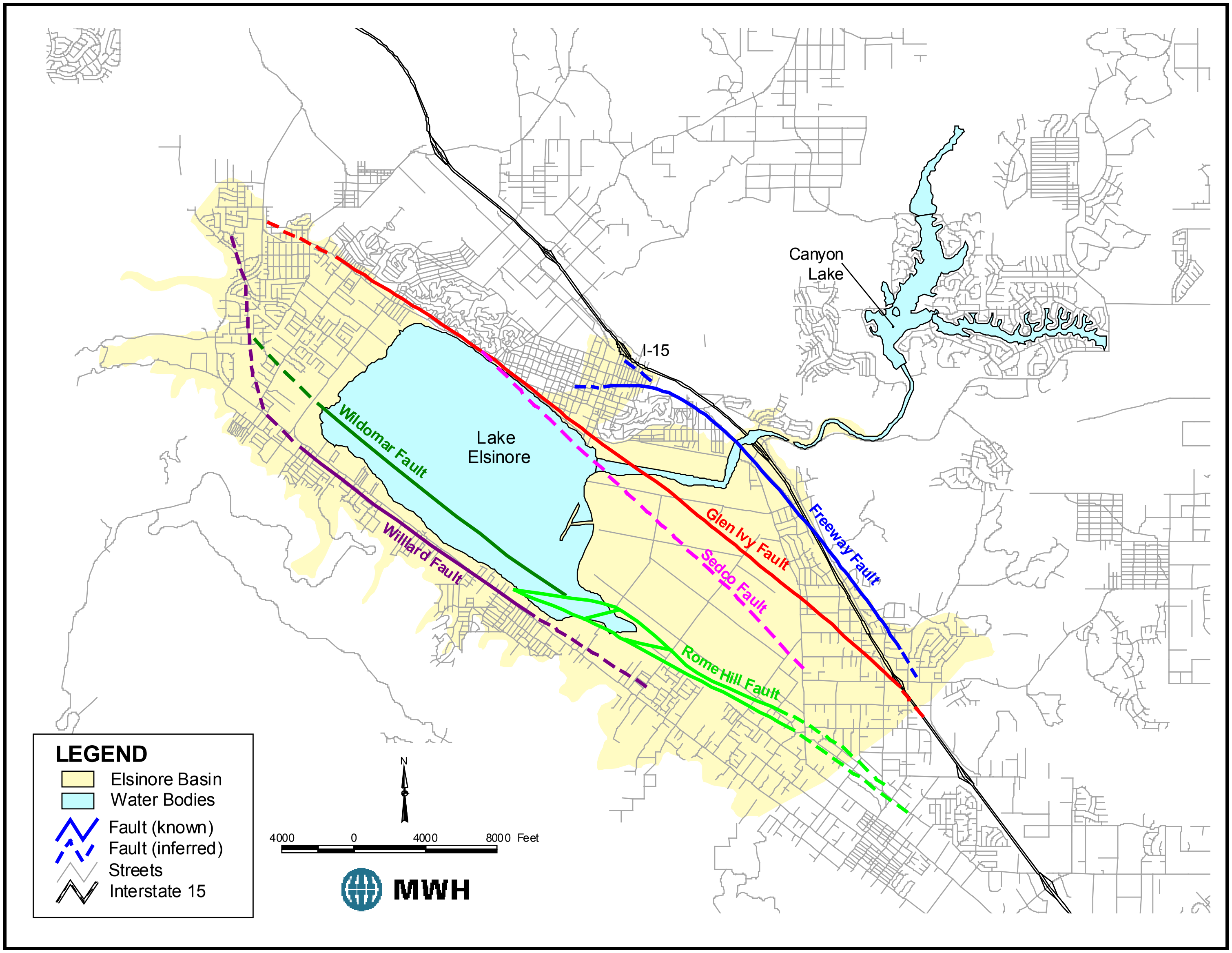
The geology and structure of the Elsinore Basin are important to the understanding of the basin hydrogeology.

Geologic Setting

Figure 2-2 presents a map of the faults within the Elsinore Basin. The Elsinore Basin was formed within the Elsinore graben, a down-dropped block between the Glen Ivy and Wildomar faults (see **Figure 2-2**), which are associated with the right-lateral strike-slip-dominated Elsinore Fault Zone (EFZ). The EFZ extends approximately 120 miles from Baja California north to the Corona area, where it divides into the Whittier and Chino faults. As the Elsinore Basin was formed by faulting throughout geologic time, it would have likely been occupied by various streams, rivers and lakes similar to the San Jacinto River and Lake Elsinore of today. For example, the San Jacinto River, which currently flows through Railroad Canyon, has probably taken more than one course and may have been in various different locations in its history. As a result, the geology and structure of the Elsinore Basin is complex.

The basement rocks within the Elsinore area generally consist of granodiorite, tonalite and diorite rocks of Jurassic to Cretaceous age (Neblett and Associates, 1998). Metasedimentary rocks (slates and sandstones) of Jurassic age are also encountered. Overlying the basement rocks within the basin, are medium to coarse-grained non-marine sandstones, siltstones and clay of the Pauba Formation (DWR, 1981). The Pauba Formation is overlain by flood plain deposits of late Pleistocene to Holocene age consisting of interfingering sands, silts and clays. Overlying these deposits are relatively unconsolidated Holocene lacustrine sands, silts and clays associated with the ancient San Jacinto River and Lake Elsinore.

Figure 2-2
Faults of the Elsinore Basin



Hydrostratigraphy

Figure 2-3 shows the general hydrostratigraphy of the Elsinore Basin. The following descriptions of the hydrostratigraphy are presented from shallowest to deepest. **Figure 2-4** presents a geologic map of the Elsinore Basin**.** The hydrostratigraphic units depicted on **Figure 2-4** include: the Recent alluvium (Qal), the Older alluvium (Qt), the Fernando Group (TQf), the Bedford Canyon Formation (bcb) and undifferentiated basement rocks (bct). Descriptions of these units are described below.

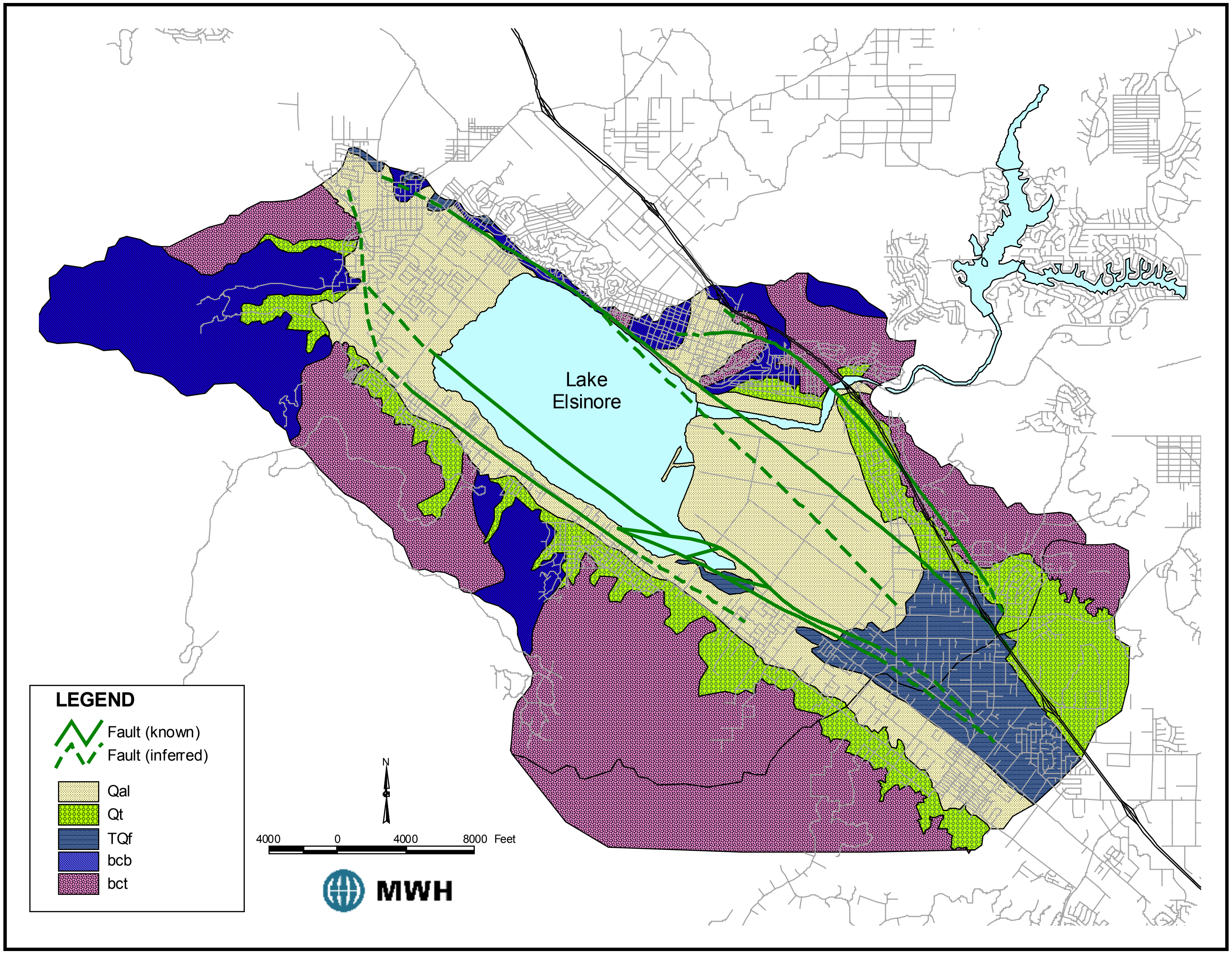
Recent Alluvium

The Recent alluvium (Qal) is the youngest of the water-bearing formations in the Elsinore Basin (Geoscience, 1994). It consists of interfingering gravels, sands, silts and clays resulting from streams originating in the surrounding highland areas. Most of these interfingering lenses are laterally discontinuous and do not correlate well across long distances. The Recent alluvium is more than 300 feet thick in some portions of the basin, particularly in the center of the basin.

Figure 2-3
Hydrostratigraphy in the Elsinore Basin

Formation	Symbol	Graphic	Description
Recent Alluvium	Qal		Interfingering sands and clays
			Perched groundwater conditions present
Older Alluvium	Qt		Interfingering sands and clays
			Slightly more consolidated than above
Fernando Group	TQf		Poorly sorted, subangular granitic sands, cobbles, and boulders
			Most produced groundwater comes from this zone
Bedford Canyon Formation	bcb		Blue to black slate and sandstone
			Relatively low groundwater production rates in this zone
Undifferentiated Basement	bct		Granitic basement rocks
			Limited groundwater production except in fractures

Figure 2-4
Geology of the Elsinore Basin



Source:Geoscience, 1994 and CDMG, 1969.

In many locations, perched groundwater conditions exist within the Recent Alluvium. Perched groundwater can be found within the upper 25 feet, particularly in the Back Basin where as much as 100 feet of impermeable clay occurs at or near the surface, impeding percolation of water to the deeper aquifers.

Older Alluvium

The Older alluvium (Qt) is similar to the Recent alluvium, consisting of interfingering gravels, sands, silts and clays of stream origin (Geoscience, 1994). The Older alluvium, like the Recent alluvium, is up to 300 feet thick. Because of their similar depositional environments, there does not appear to be a clear and definitive lithologic marker unit between the Recent and Older alluvium that could be determined from well log information. However, the Older alluvium is generally more consolidated and contains more clay than the Recent alluvium (Geoscience, 1994). Therefore, for the purposes of this report, the Recent and Older alluvium will be referred to simply as alluvium (Qa).

Fernando Group

The Fernando Group (TQf) is characterized by poorly sorted, subangular granitic sands and gravels with laterally discontinuous lenses of silts and clays correlative with the early Pleistocene Pauba Formation, located to the southeast in the Murietta area (Geoscience, 1994). The boundary between the alluvial aquifers and the Fernando Group is marked by a relatively continuous clay aquitard that extends throughout most of the central portion of the basin beneath Lake Elsinore. The Fernando Group is thin or absent along the margins of the basin and is as much as 1,200 feet thick in the center of the basin.

Bedford Canyon Formation

The Bedford Canyon Formation (bcb) is characterized by blue to black slate alternating with layers of fine-grained sandstones of Jurassic age that underlies the Fernando Group throughout the basin (Geoscience, 1994). Lithology identified as Bedford Canyon includes the more consolidated sedimentary section beneath the Fernando Group between the Wildomar fault and the Glen Ivy fault in the deepest part of the basin. Groundwater in the Bedford Canyon formation is limited to the weathered zones at shallow depths and fractures at depth and generally does not produce significant groundwater supplies. The Bedford Canyon Formation is also found in the highland areas of the northern portion of the basin – these areas do not produce significant groundwater supplies (Geoscience, 1994).

Undifferentiated Basement Complex

The basement rocks (bct) in the Elsinore Basin are characterized by igneous granites, tonalites, gabbros and minor basalt of Jurassic to Cretaceous age (Geoscience, 1994). These rocks do not generally produce significant groundwater except in fractures, and are found at the surface in the highlands surrounding the basin. In the basin area itself, the depth to bedrock ranges from about 200 feet near the edge of the Basin (Leach and McVicker Canyons) to as much as 2,800 feet in the Back Basin area.

Structure

As discussed previously, the Elsinore Basin is dominated by the Elsinore graben, a down-dropped block between the Glen Ivy Fault Zone and the Wildomar Fault Zone located to the north and south of Lake Elsinore, respectively. The following section provides a brief discussion of the structure in the Elsinore Basin as it relates to groundwater flow in the basin.

Faults

Two major fault zones form the Elsinore Basin. These are the Glen Ivy Fault Zone, which includes the Glen Ivy fault, the Freeway fault and the Sedco fault, and the Wildomar Fault Zone, which includes the Wildomar fault, the Rome Hill fault, and the Willard fault. These faults are shown on **Figure 2-2**. These faults are steeply dipping (nearly vertical) with predominant dip-slip and minor right-lateral strike-slip motion.

Other faults identified by DWR (1981), which subdivided the Elsinore Basin into additional hydrogeologic compartments, appear to be limited to the basement rocks and do not appear to provide barriers to or restrict groundwater flow.

The Freeway fault, which also offsets basement rocks, is located along the I-15 freeway in the northern portion of the basin. This fault does not appear to restrict subsurface flow from the surrounding highlands either.

The Sedco fault, which is located in the Back Basin area, has been extensively studied as part of the Back Basin Pilot Injection Program (BBPIP). Based upon data collected during a pilot injection test, the Sedco fault does not appear to restrict groundwater flow in the Back Basin area. Water level differences and analysis of the sources of groundwater recharge across the fault indicate the Glen Ivy fault is at least a partial barrier to groundwater flow.

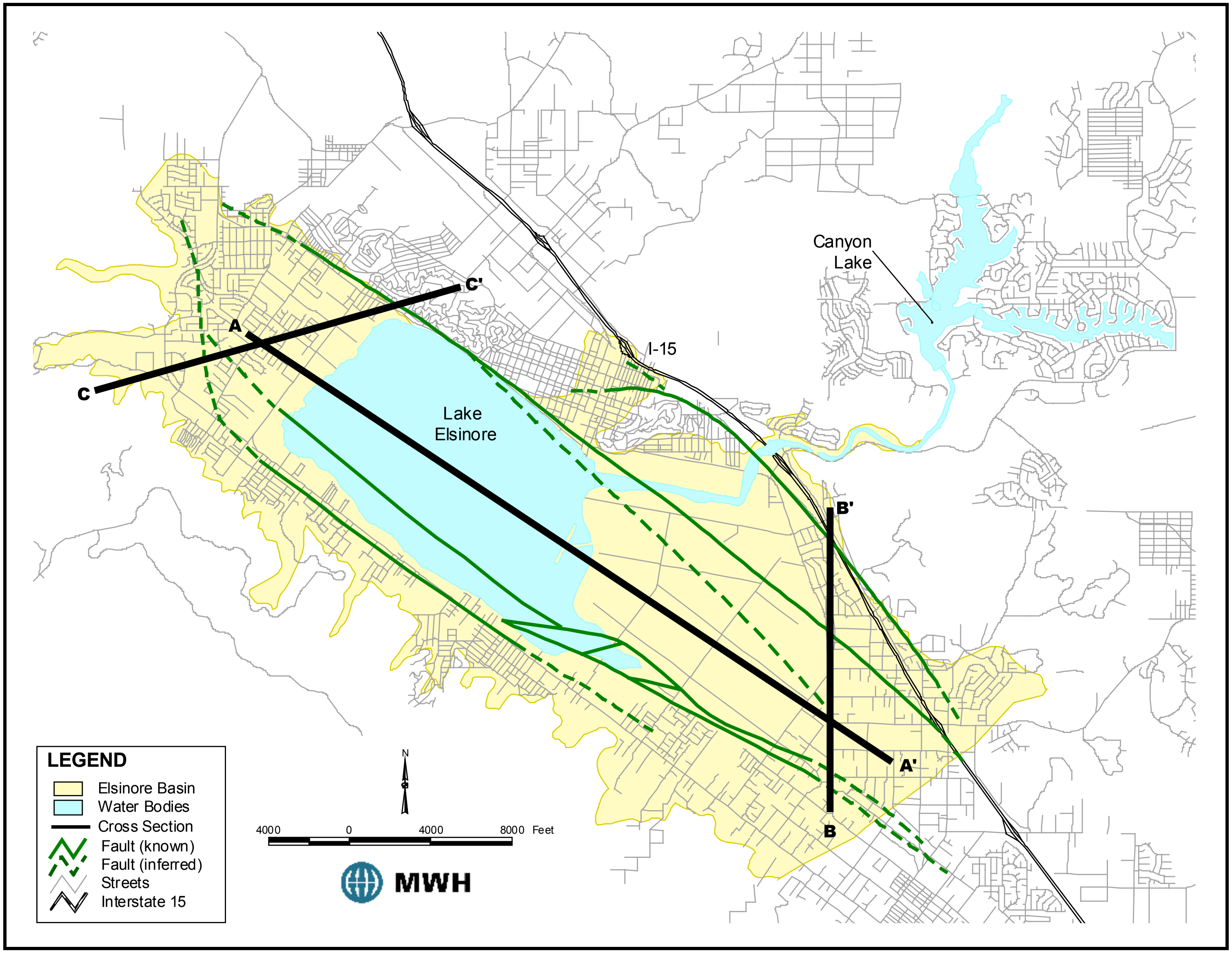
The Rome Hill fault, which is part of the Wildomar Fault Zone, results in the local surface high called Rome Hill. Because of the extensive faulting and differences in water levels across this fault, it is probably a barrier to groundwater flow. Therefore, subsurface flow from the surrounding highlands south of the fault, do not appear to provide recharge to the central portion of the basin.

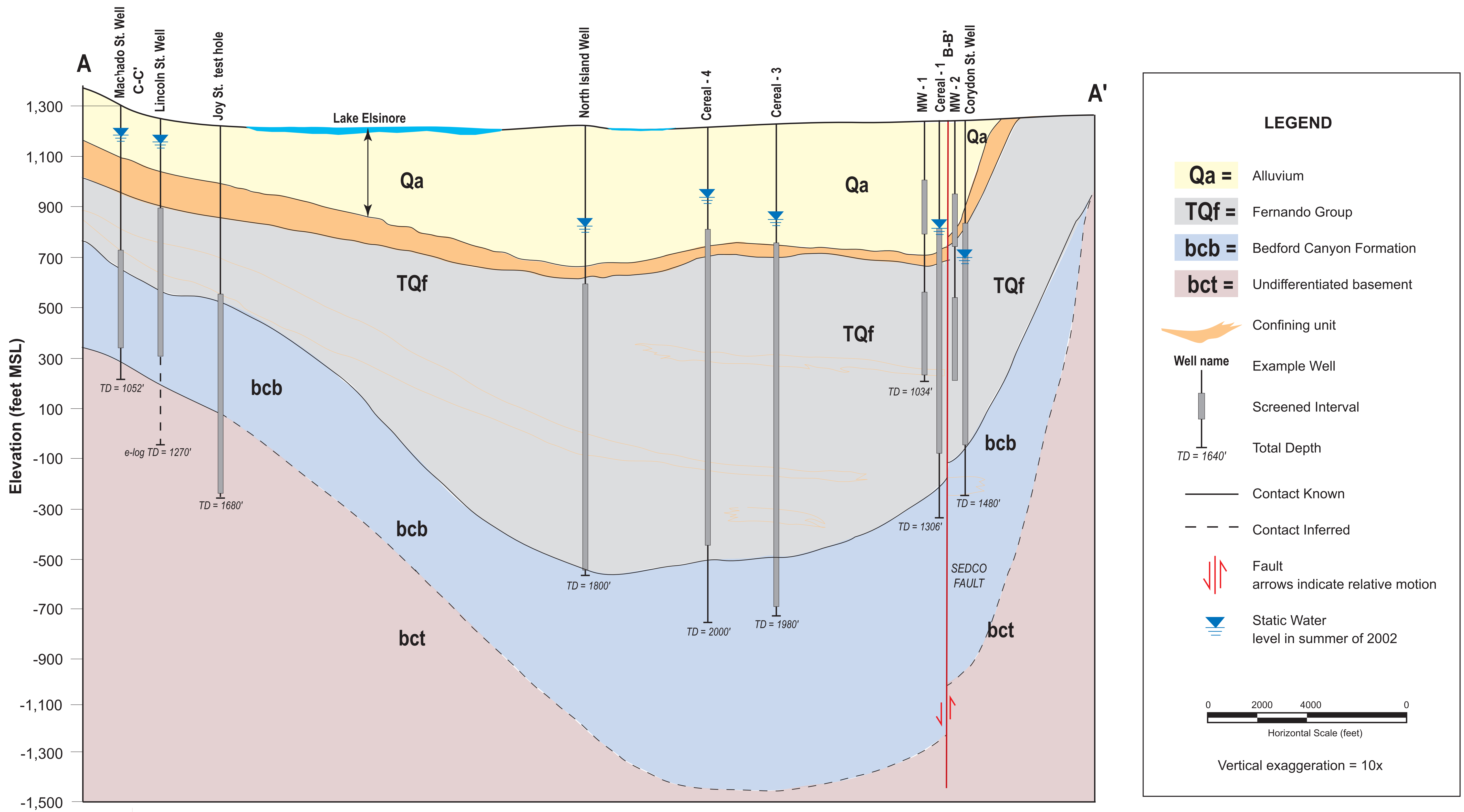
The Willard fault, which extends along Grand Avenue along the southeast and eastern side of the basin, offsets basement rocks in the area and does not appear to be a barrier to groundwater flow. Similarly, the parallel Wildomar fault also does not appear to be a barrier to groundwater flow.

Conceptual Hydrogeologic Sections

To provide a description of the conceptual hydrogeology and overall structure of the Elsinore Basin, three hydrostratigraphic cross sections have been constructed in various locations in the basin. The locations of the cross sections are presented in **Figure 2-5**. The cross sections are presented in **Figure 2-6** through **Figure 2-8.** Information presented on the cross sections is developed from data compiled from driller's logs, geophysical logs, water level data, seismic studies and interpretation developed during the course of this investigation. Structural contour maps depicting the tops and bottoms of key aquifer units are also presented in **Appendix C**.

Figure 2-5
Location of Cross Sections

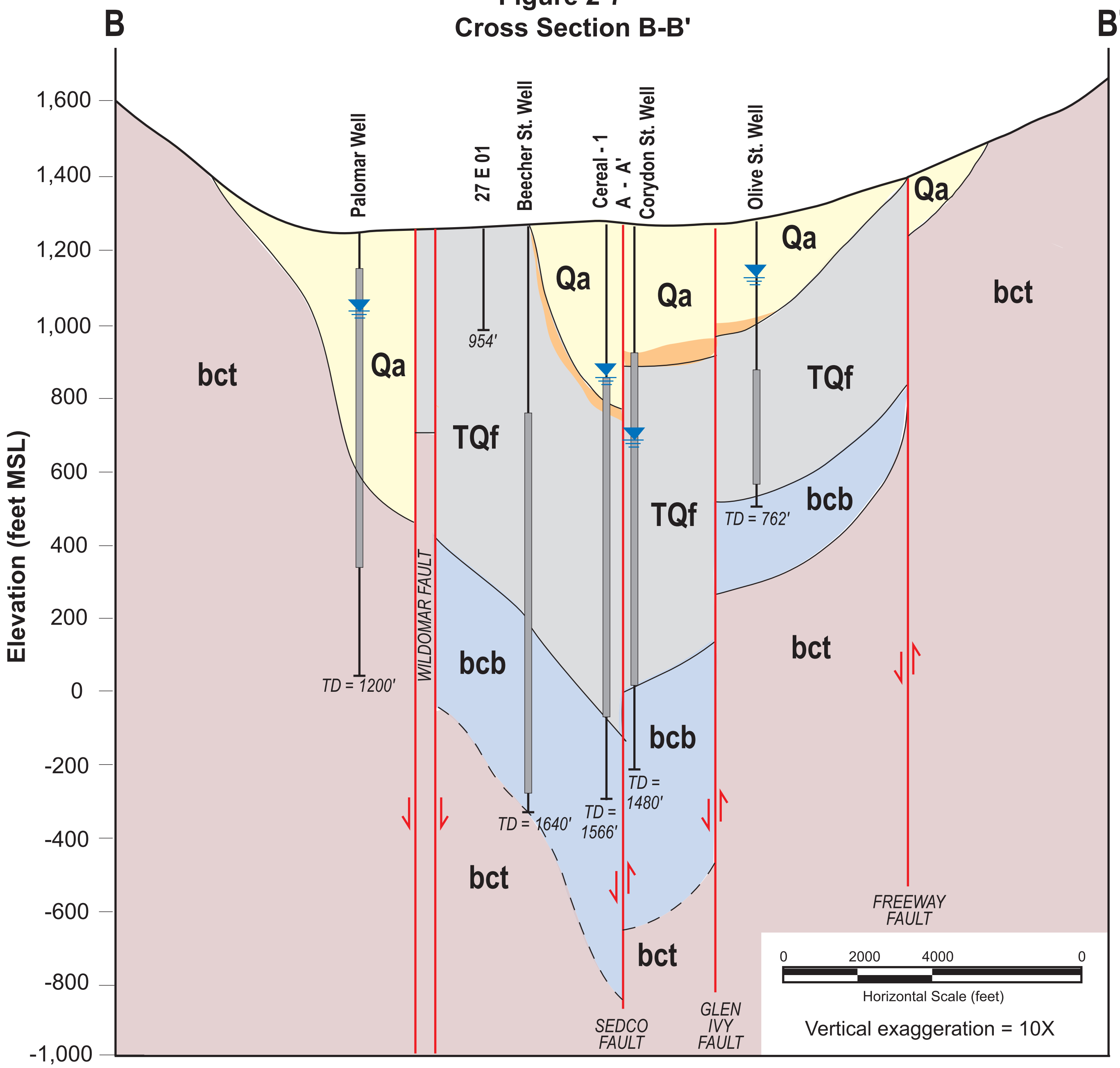




MWH

Figure 2-6
Cross Section A-A'

Figure 2-7
Cross Section B-B'



LEGEND

Qa = Alluvium

TQf = Fernando Group

bcb = Bedford Canyon Formation

bct = Undifferentiated basement

Well name

Example Well

Screened Interval

Total Depth

TD = 1640'

Confining unit

Contact Known

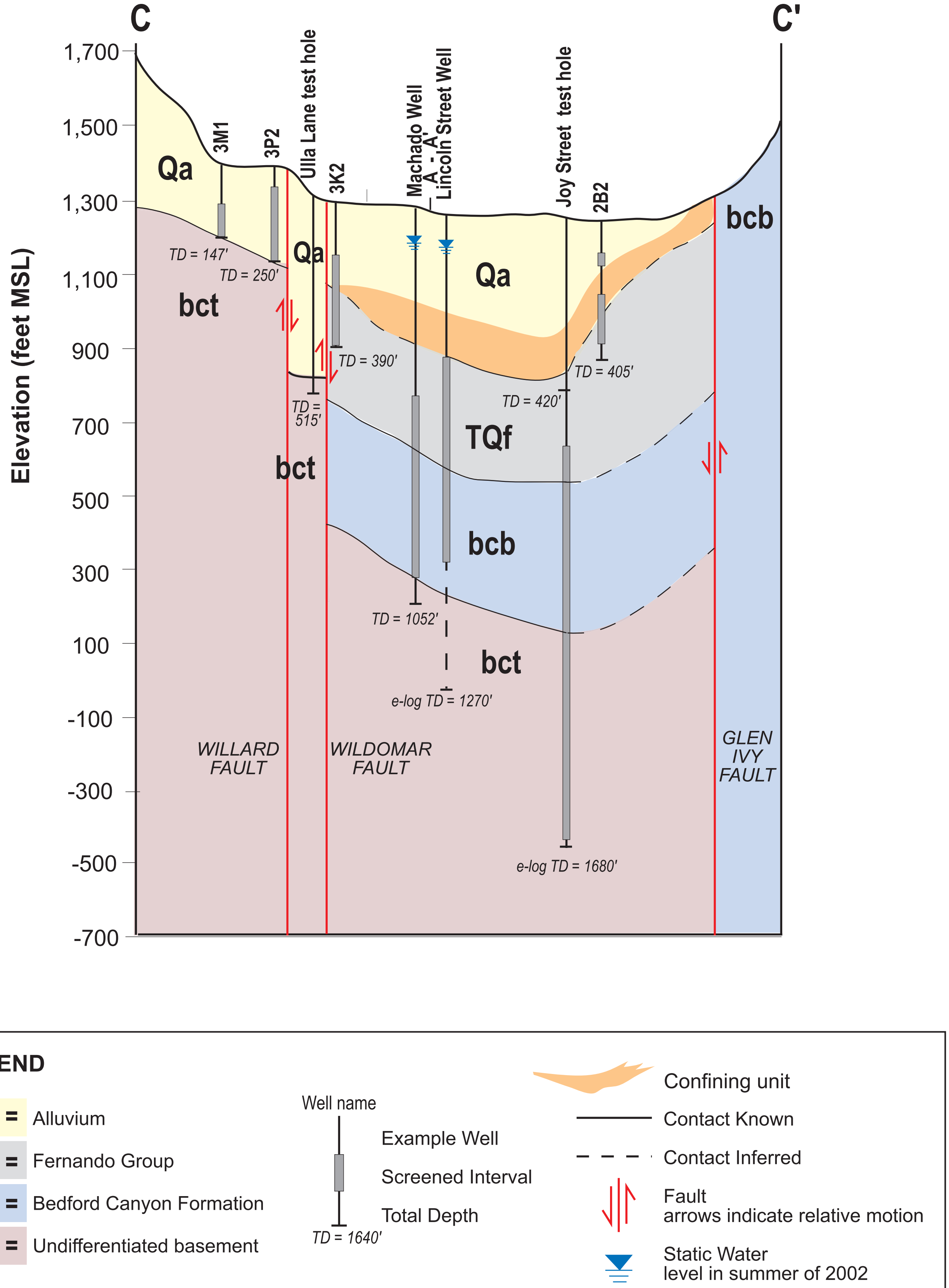
Contact Inferred

Fault
arrows indicate relative motion

Static Water
level in summer of 2002

MWH

Figure 2-8
Cross Section C-C'



MWH

Cross Section A-A'

This cross section extends approximately 7.5 miles longitudinally across the basin parallel to the long axis of the basin from approximately Grand Avenue on the northwest to Mission Trail on the southeast. The alluvium (shown as Qa on the section) ranges in thickness from about 200 feet in the northwest to more than 450 feet in the southeast part of the section.

The Sedco fault offsets the alluvium by about 20 to 40 feet in the Back Basin area based upon geophysical logs from several wells (i.e. Cereal-1, Corydon, MW-1 and MW-2) in the Back Basin area. The clay aquitard, which is relatively continuous throughout the basin, separates the alluvium from the underlying Fernando Group.

The Fernando Group (shown as TQf on the section) is also present throughout the basin underlying the alluvium. In the southeast part of the section, the alluvium is not present and the Fernando Group is actually uplifted to the surface. The Fernando Group extends to a depth of approximately 700 feet overlying the Bedford Canyon Formation in the area north of the lake. In the Back Basin area, the Fernando Group extends to a depth of as much as 1,800 feet below ground surface (fbgs) in the vicinity of the Island wells and is underlain by a more consolidated, less permeable Bedford Canyon Formation. The Sedco fault offsets the Fernando Group by as much as 150 feet between the Cereal-1 and Corydon Street wells. In the Wildomar area southeast of the Corydon well, the bedrock surface is uplifted to an elevation of about 900 feet above mean sea level (MSL), creating a barrier to groundwater flow toward the Murietta Basin. This limits the volume of the basin between the Sedco fault and the Glen Ivy fault.

As shown in the section, water levels in wells that are screened in the alluvium are generally higher than water levels in wells that are screened solely within the Fernando Group or the underlying Bedford Canyon Formation. This suggests that there is limited hydrogeologic connection between the alluvium and the Fernando Group. The general groundwater flow direction is from the northwest to the southeast, largely a result of groundwater extraction in the Back Basin. The difference in groundwater levels between the Cereal-1 well, which is screened in both the alluvium and the Fernando Group, and the Corydon Street well, which is screened only in the Fernando Group, appears to be a result of the relative head differences between these two zones.

Cross Section B-B'

Cross Section B-B' extends about 4 miles from south to north through the Back Basin. This section shows the various faults through the Back Basin (from south to north the Wildomar Fault Zone, the Sedco fault, the Glen Ivy fault and the Freeway fault). Depth to bedrock and the resultant alluvial thickness is largely controlled by bedrock faulting in the area. For example, the Fernando Group and the Bedford Canyon Formation generally thicken toward the center of the basin. However, these formations are not found along the boundaries of the basin (north of Freeway fault and south of Wildomar fault) in this area, likely a result of erosional processes caused by downdropping of the bedrock. The thicknesses of these units are also variable across faults. The vertical offset in the bedrock along the Wildomar Fault Zone (which includes the extension of the Wildomar fault and the Rome Hill fault) is as much as 400 feet. Between the Wildomar Fault Zone and the Sedco fault, the bedrock surface undulates from faulting in the bedrock. The vertical offset in the bedrock along the Sedco fault is more than 200 feet. The vertical offset along the Glen Ivy fault is more than 500 feet. The Freeway fault contact is inferred and the offset shown is estimated based upon surface geology.

Cross Section C-C'

Cross Section C-C' extends about 3 miles east-northeast from Leach Canyon past Lakeshore Drive along the northern side of Lake Elsinore. Like the Back Basin area, faulting largely controls the basin geometry in this area. This section identifies the locations of the Wildomar, Willard and Glen Ivy faults.

The alluvium in this part of the basin is generally thinner than in the Back Basin area. The depth to bedrock in the area of Leach Canyon ranges from 200 to 250 fbgs near the mouth of the canyon. Depth to bedrock in the center of the basin ranges from 1,000 to 1,200 fbgs. The thickness of the alluvium is about 200 feet in the central portion of the section. In the western portion of the basin, the alluvium is underlain directly by the granite basement complex because the Fernando Group and Bedford Canyon Formation are not present, likely a result of erosional processes. East from the Wildomar fault, the Fernando Group and the Bedford Canyon Formation underlie the alluvium. The Fernando Group is approximately 200 feet thick throughout this area.

The Fernando Group is underlain by the Bedford Canyon formation in this part of the basin. As discussed above, the Bedford Canyon Formation is characterized by metamorphosed sedimentary rocks (slates and sandstones) and has limited groundwater production capability. Many of EVMWD's wells including Lincoln Street and Machado Street appear to be screened at least partially within the Bedford Canyon Formation, which may explain their relatively low production rates compared to the wells of the Back Basin.

Aquifer Characteristics

The primary source of data on aquifer characteristics is from pump tests. **Table 2-2** summarizes the aquifer characteristics based upon data compiled from DWR well logs and pumping tests performed throughout the basin.

Based upon aquifer tests performed in the Corydon Street well and the North, Middle and South Island wells, transmissivity values for the Fernando Group in the Back Basin range from about 103,000 to 154,000 gpd/ft, consistent with a general sand lithology. Aquifer tests for the Cereal-3 and Cereal-4 wells, which are screened in both the Fernando Group and a small portion of the overlying alluvium, suggested transmissivity values ranging from 130,000 to 150,000 gpd/ft (Fox, 1991a and 1991b). The average transmissivity of these screened sections are slightly higher than those screened exclusively in the Fernando Group, which suggests that the alluvium has a higher hydraulic conductivity than the underlying Fernando Group.

Table 2-2
Summary of Aquifer Characteristics

Well Name	Aquifer	Saturated Screen Length (b) ft	Transmissivity (T) gpd/ft	Storativity (s)	Source
North Well	TQf	1,200	138,000 [1]	0.00037	Geoscience, 1990
Middle Well	TQf	1,167	159,000 [1]	0.00660	Geoscience, 1990
South Well	TQf	1,200	104,000 [1]	0.00550	Geoscience, 1990
Cereal-1	Qa and TQf	990	112,000 [1]	0.0035	This study
Cereal-3	Qa and TQf	1,330	130,000-140,000 [1]	NA	Fox, 1991b
Cereal-4	Qa and TQf	1,180	140,000-154,000 [1]	NA	Fox, 1991a
Corydon Street	TQf	920	103,000-123,000 [1]	NA	Fox, 1985
Olive Street	TQf	300	38,000 [2]	NA	Geoscience, 1994
Lincoln Street No. 1	Qa, TQf and bcb	817	16,000 [2]	NA	Geoscience, 1994
Lincoln Street No. 2	TQf and bcb	580	34,000 [2]	NA	Geoscience, 1994
San Jacinto	Qa	300	17,000 [2]	NA	Geoscience, 1994
Beecher Street	TQf and bcb	780	116,000 [2]	NA	Geoscience, 1994
Fraser No. 1	Qa and TQf	220	24,000 [2]	NA	Geoscience, 1994
Machado Street	TQf and bcb	390	19,000 [2]	NA	DWR well log

Notes:

1 Calculated from aquifer test data

2 Calculated from specific capacity data assuming T = specific capacity x 2,000/well efficiency (rounded to nearest 1,000)

Often, direct field measurements of transmissivity and horizontal hydraulic conductivity are not available. To establish a range of transmissivity values for the principal water-bearing units, all available specific capacity data (well yield per foot of drawdown), which is a related parameter, are compiled. The transmissivity of a confined aquifer can be approximated by multiplying the specific capacity by a constant of approximately 2,000 (Logan, 1964). Sources of specific capacity data included well driller's logs, purveyor's records and published data. Although specific capacity is a relative measure of the transmissivity of the aquifer, each specific capacity measurement is evaluated with caution because specific capacity is often affected by partial penetration of the aquifer, well losses, hydrogeologic boundaries and pumping time. Few of these wells are screened in only one water-bearing zone; therefore, aquifer-specific transmissivity estimates are not available. Furthermore, many wells are also screened across less permeable units, which would result in lower specific capacity values for the aquifer portions of the screened section. Therefore, aquifer-specific transmissivities that are calculated from specific capacity data should be considered a lower limit.

No in-situ measurements of horizontal hydraulic conductivity are available so hydraulic conductivity estimates are made from transmissivity. Hydraulic conductivity is defined by the following equation:

$$T/b = k$$

where:
T = transmissivity
b = saturated aquifer thickness and
k = hydraulic conductivity

Based upon the transmissivity estimates provided in **Table 2-2**, horizontal hydraulic conductivity ranges from about 3 ft/day in the area north of the lake to about 19 ft/day in the Back Basin area. This range in hydraulic conductivity is consistent with a silty to medium sand lithology, which is present throughout the Elsinore Basin.

No direct measurements of vertical hydraulic conductivity are available for any of the various hydrogeologic units. In most cases, the vertical hydraulic conductivity is expected to be much less (in some cases orders of magnitude) than the horizontal hydraulic conductivity. Even within relatively homogenous sand and gravel aquifers, horizontal hydraulic conductivity will generally exceed vertical hydraulic conductivity by 2 to 20 times (Todd, 1980). If silts and clays are present, this contrast will be even greater. Thin lenses of sediments with low bulk hydraulic conductivity (such as the clays common in the study area) typically have an insignificant effect on horizontal conductivity, but they have a significant effect on vertical conductivity.

Storage coefficients derived from aquifer tests range from 0.00037 to 0.0060, consistent with confined or semi-confined aquifers. Based upon preliminary data evaluated as part of the BBIPP, calculated values of transmissivity in the alluvium range from about 80,000 gpd/ft to nearly 312,000 gpd/ft. Calculated values for the storage coefficient in the alluvium ranged from 0.011 to 0.0087, which are consistent with an unconfined or semi-confined aquifer system.

GROUNDWATER LEVELS

The following section describes the historical groundwater flow conditions for the Elsinore Basin. A summary of recent groundwater elevations is provided in **Table 2-3**.

General Groundwater Flow

As shown in Cross Section A-A’, groundwater currently flows from the northwest to the southeast beneath Lake Elsinore (see **Figure 2-6** and **Figure 2-9**). Based upon the limited groundwater level data available, the average groundwater gradient in the Fernando Group is approximately 0.016 in the central part of the basin. This gradient is very steep and reflects the extensive pumping in the Back Basin area. The groundwater surface elevation within the Fernando Group in the central portion of the basin during the summer of 2002 ranged from 1,196 feet MSL (MSL) in the Machado Street well to 698 feet MSL in the Corydon Street well. Based upon water levels within the Fernando Group from the new monitoring wells MW-1 and MW-2, the gradient steepens toward the Corydon Street well. The groundwater elevation in the Olive

Street well, which is on the upthrown side of the Glen Ivy fault (see Figure 2-7), is 1,156 feet MSL, more than 400 feet higher than water levels in the Corydon Street well about a mile away. This suggests that the Glen Ivy fault provides at least a partial barrier to groundwater flow. However, observed vertical offsets in the bedrock associated with Glen Ivy fault may also cause these water level differences.

Table 2-3
Summary of Groundwater Elevations – Summer 2002

Well Name	Aquifer	Groundwater Elevation (ft MSL)
Cereal-1	Qa and TQf	843
Cereal-3	Qa and TQf	879
Cereal-4	Qa and TQf	953
Corydon Street	TQf	698
Lincoln Street	TQf and bcb	1168
Machado Street	TQf and bcb	1196
MW-1 Deep	TQf	859
MW-1 Shallow	Qa	1032
MW-2 Deep	TQf	845
MW-2 Shallow	Qa and TQf	955
North Island Well	TQf	877
Olive Street	TQf	1156
Palomar Street	Qa	1074
South Island Well	TQf	900

The groundwater elevations for wells partially or entirely screened within the alluvium are shown in **Figure 2-10**. Because no production wells for which water level data are available are screened entirely in the alluvium, it is not possible to create a contour map for wells within the alluvium. However, the average gradient between the wells Cereal-4 and Cereal-1, which are all screened in both the alluvium and the Fernando Group is approximately 0.012, similar to the gradient within the Fernando Group. Water levels in monitoring wells MW-1 and MW-2, which have piezometers screened exclusively in the alluvium, are about 100 to 150 feet higher than wells that are also screened in the Fernando Group. The Palomar well, located on the south side of the Wildomar Fault Zone, has a water elevation of 1,074 feet MSL. Because no other water level data are available for the area near the Palomar well during 2002, it is not possible to contour water levels in this area for this time period.

Figure 2-9
Groundwater Contour Map
Fernando Group – Summer 2002

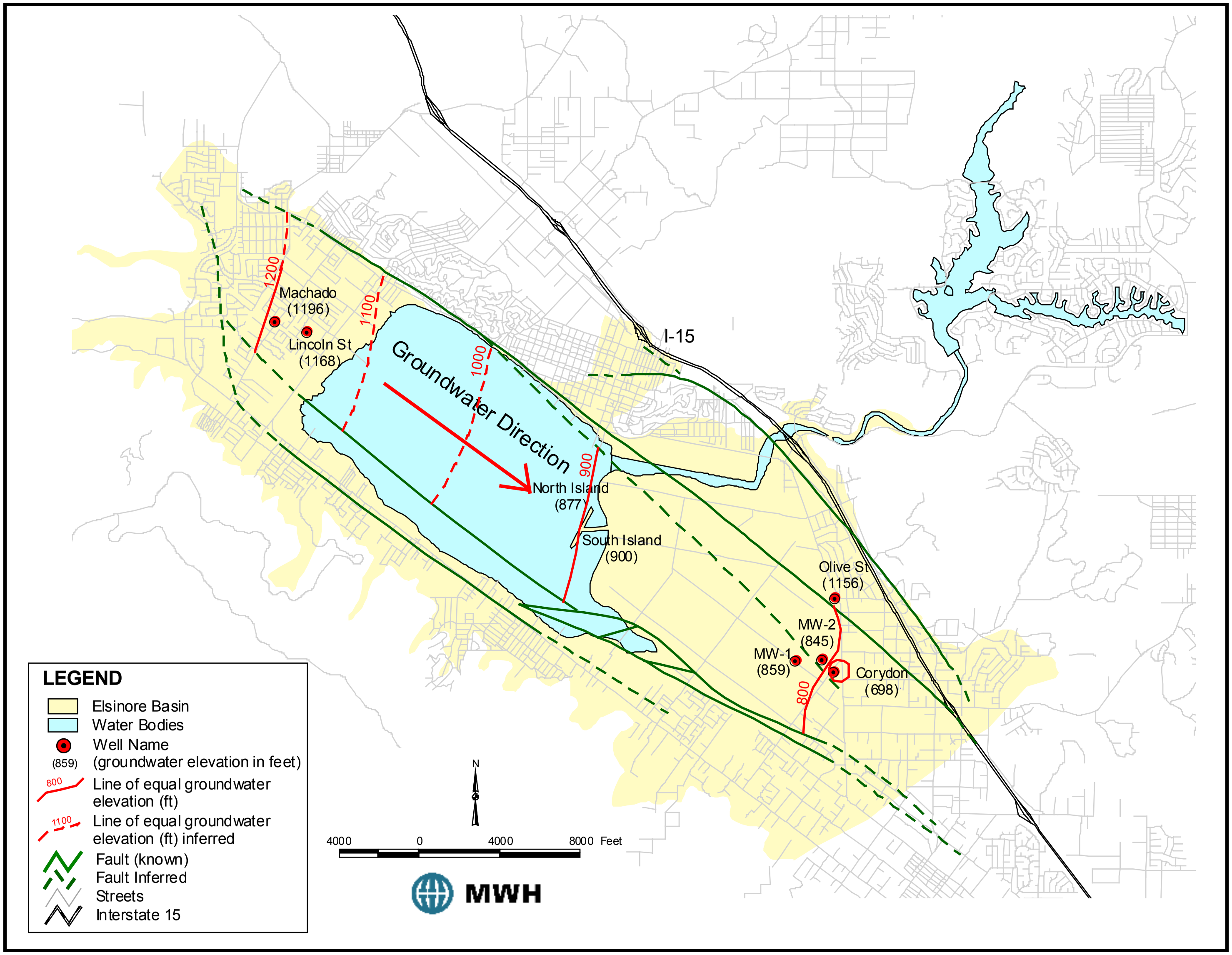
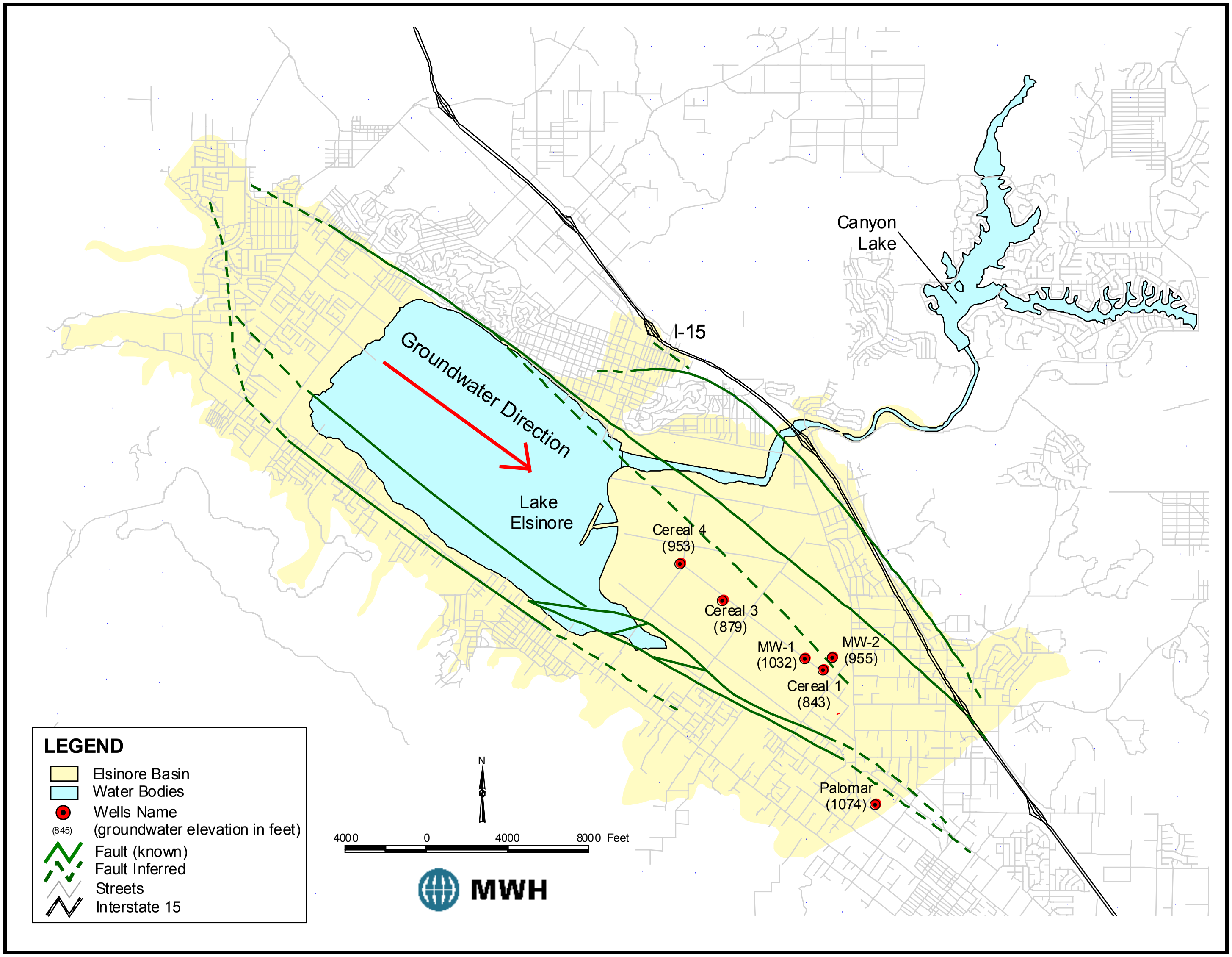


Figure 2-10
Groundwater Level Map
Alluvium and Fernando Group– Summer 2002



Historical Groundwater Levels

An evaluation of historical groundwater levels is important to understanding the behavior of the groundwater basin over a period of time. Historical groundwater levels in the Elsinore Basin are described below.

Fernando Group

Figure 2-11 shows historical water levels for select wells that are screened within the Fernando Group, but not in the alluvium. The water levels in the Lincoln Street Well, which is located in the area north of the lake, generally follow historical trends in precipitation as indicated by the cumulative departure from mean precipitation curve. The water levels in the Corydon Street and North Island wells are decreasing steadily and have decreased more than 200 feet since the early 1990s. This is consistent with the basin geometry, which suggests that the Back Basin area has limited natural recharge to the Fernando Group and that most of the pumping occurs in this portion of the basin. The area north of the lake appears to have a source of natural recharge to the Fernando Group from surface drainages such as Leach and McVicker Canyons that infiltrate directly through the shallow alluvium into the underlying aquifers.

Alluvium and Fernando Group

Figure 2-12 presents historical water levels in select wells screened across both the alluvium (containing both the Upper and Lower alluvium defined previously) and the Fernando Group. In the Back Basin, the water levels in the alluvium are as much as 150 feet higher than in the Fernando Group. Water levels in the Cereal-3 and Cereal-4 wells have declined more than 150 feet since their construction. Water levels in the Cereal-1 well have fluctuated significantly since the well was constructed. The water levels fluctuations appear to be a function of regional pumping patterns in nearby wells (as shown in **Figure 2-12**). During the 1994 to 1996 time period, the Cereal-1 well has similar water levels to the Corydon well. This suggests that the Sedco fault, which separates the Cereal-1 well and the Corydon Street well, is not a barrier to groundwater flow.

GROUNDWATER BUDGET

A groundwater budget analysis is the quantification and reconciliation of the inflow and outflow components of the groundwater regime in the study area. The purpose of this analysis is to characterize the major contributions to groundwater flow and evaluate the relative importance of each inflow and outflow component in the hydrologic behavior of the basin. Historical variations in the various components of flow, as well as potential variations of groundwater in storage, can be used to evaluate a representative range of flow conditions in the basin.

Figure 2-11
Historical Water Levels in the Fernando Group

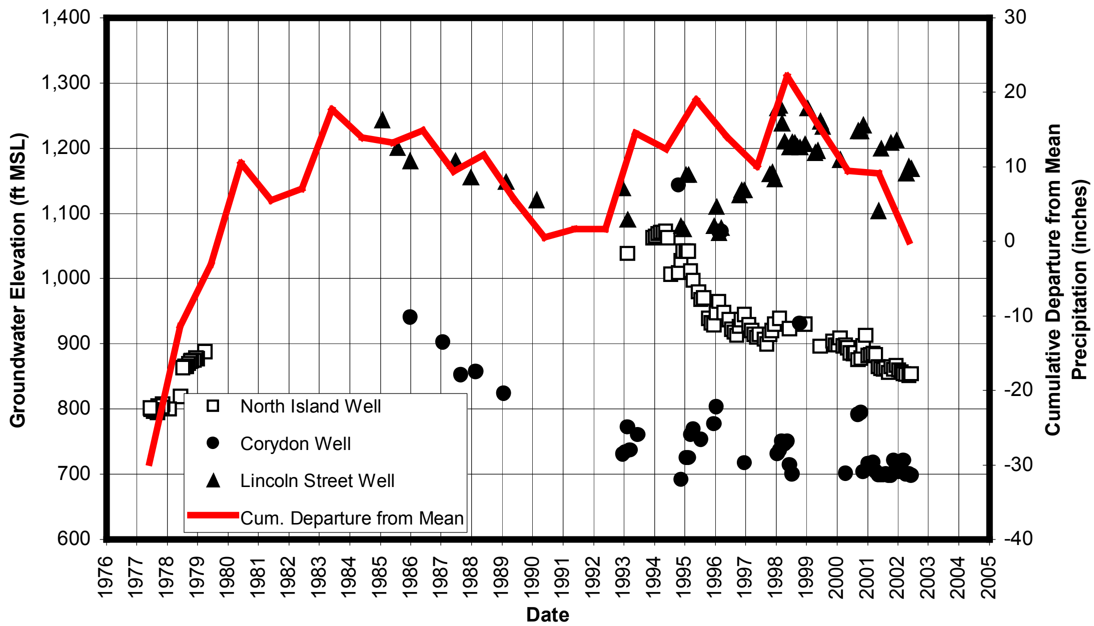
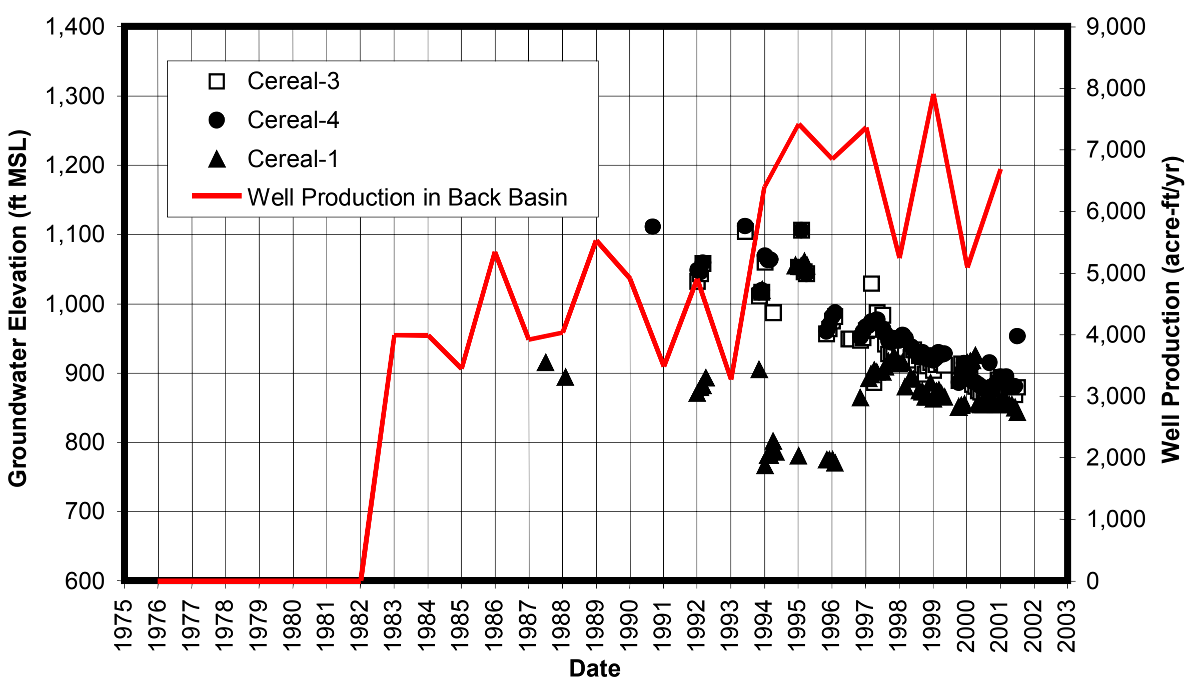


Figure 2-12
Historical Water Levels in the Alluvium and the Fernando Group



Typical components of groundwater inflows and outflows for a groundwater budget analysis are listed below:

Inflows
- Infiltration from direct precipitation
- Surface water infiltration
- Infiltration from deep percolation of applied water
- Infiltration from septic tanks
- Underflow into basin

Outflows
- Groundwater pumping
- Flow to surface water
- Underflow out of basin

Each of these potential components of inflow and outflow as they pertain to the Elsinore Basin are discussed in more detail below.

Inflows

The major inflow components to the Elsinore Groundwater Basin are:

- Recharge from precipitation – rainfall directly to the basin
- Surface water infiltration – recharge from infiltration of surface waters such as streams. The San Jacinto River is the major surface water inflow. Inflow from Lake Elsinore is considered negligible.
- Infiltration from land use – direct surface recharge from application of water for irrigation
- Infiltration from septic tanks – infiltration in areas serviced by septic systems in the basin

Precipitation Recharge

Recharge from precipitation is a significant inflow to the Elsinore Basin. The following section quantifies the historical annual average precipitation volume and the amount of this precipitation that infiltrates into the groundwater basin. The following equation is used to calculate the amount of precipitation recharge:

Precipitation Recharge = Total Precipitation –Runoff – Evapotranspiration

As shown in **Figure 2-13**, precipitation is highly variable across the watershed, ranging from approximately 11.5 inches per year in the northeastern portion of the watershed to as much as 25 inches per year in the southern (higher elevation) portion of the watershed.

In the preparation of a groundwater budget, a representative time period over which inflows and outflows are approximately equal that approximates current conditions must be selected. When pumping data and groundwater usage are not stable, precipitation is often used to select the representative time period. **Figure 2-14** shows the annual precipitation and cumulative departure from mean precipitation at Station 67 located north of Lake Elsinore. Average annual precipitation at this rain gauge since 1897 is approximately 12.3 inches.

The cumulative departure from mean precipitation, which represents the cumulative difference between the annual precipitation and the historical average precipitation, is also shown on this figure. The cumulative departure curve shows a general increasing trend in precipitation from 1897 to the early 1940s (i.e. precipitation is generally above average) and a decreasing trend from the early 1940s to the late 1970s (i.e. precipitation is generally below average). Between the late 1970s and the early 1990s and the early 1990s to the present, precipitation patterns exhibit two complete cycles of above-average and below-average precipitation.

Based upon the data presented in **Figure 2-14**, the base period for the groundwater budget selected for this study is from 1990 to 2000. This 11-year period includes both wet and dry periods and has an average precipitation of approximately 13 inches per year, slightly higher than that for the historical period. Cumulative departure from mean precipitation is approximately equal at each end of this time period, which suggests similar hydrologic conditions at the beginning and the end of the time period.

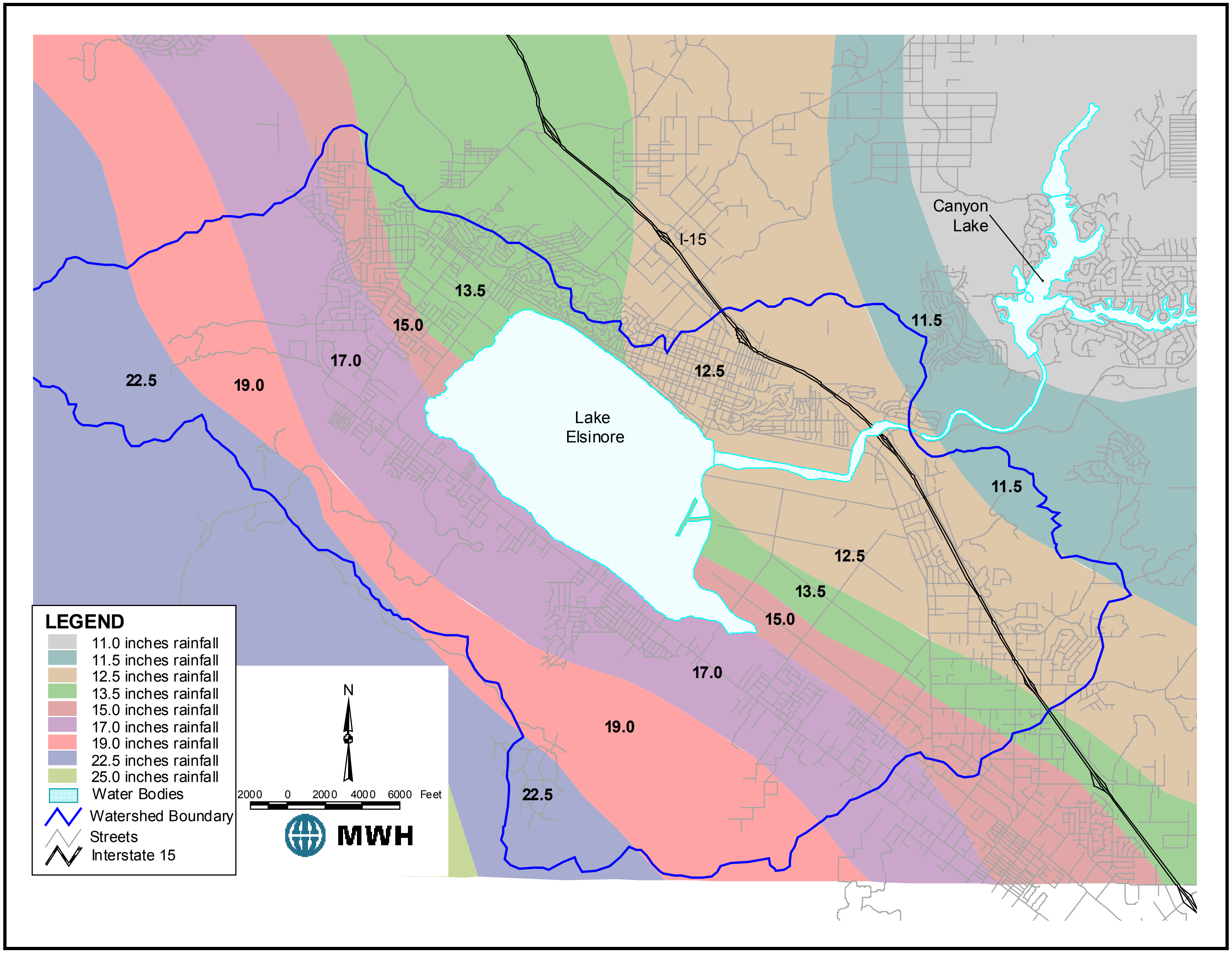
Because the methods for determining the runoff coefficients and associated infiltration rates in the open space areas and the urban areas are different, each component will be discussed separately. Runoff and evapotranspiration estimates for each category are described below.

Recharge from Precipitation in Open Areas

Runoff coefficients based upon various vegetation types, soil types and rainfall intensity are estimated using the methodology described in the Riverside County Flood Control District Hydrology Manual (Riverside County Flood Control District, 1978). As shown in **Figure 2-15**, the vegetation cover in the tributary open areas to the Elsinore Basin is characterized by chaparral and canyon live oak. Chaparral is present throughout most of the watershed area with minor areas of canyon live oak in the northwest portion of the watershed in the vicinity of Leach and Dickey canyons.

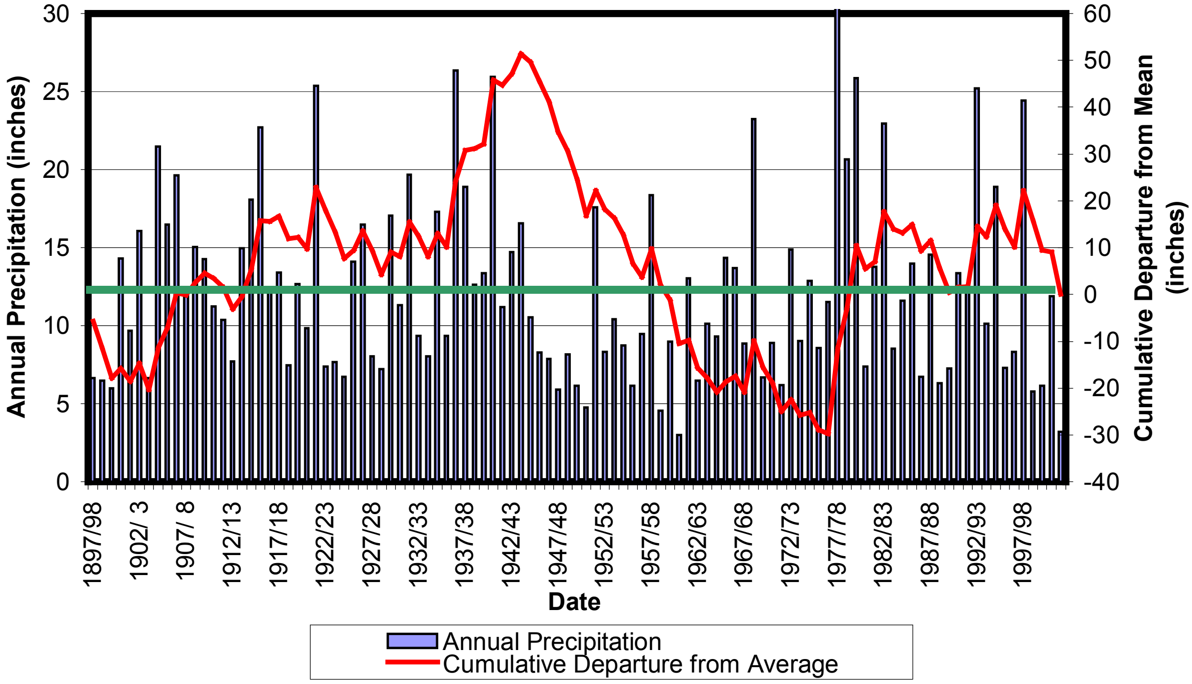
Soils are classified by RCFCD according to their ability to infiltrate water, ranging from Type A (higher infiltration) to Type D (very low infiltration). Most of the open areas in the watershed have B soil types characterized by moderate infiltration rates (RCFCD, 1978). In the northwest portion of the watershed, there are some areas of Type A soil characterized by high infiltration rates. Runoff coefficients are estimated for each subwatershed based on the soil types and vegetative cover. An antecedent moisture condition (AMC) value of I is used to determine the runoff coefficients because most storms occur under dry ambient conditions. Runoff coefficients used for this analysis ranged from 0.3 to 0.5.

Figure 2-13
Isohyetal Map of Elsinore Watershed



Source: Riverside County Flood Control and Water Conservation District, Isohyetal Map of Average Annual Precipitation.

Figure 2-14
Historical Annual Precipitation
Riverside County Flood Control District – Station 67



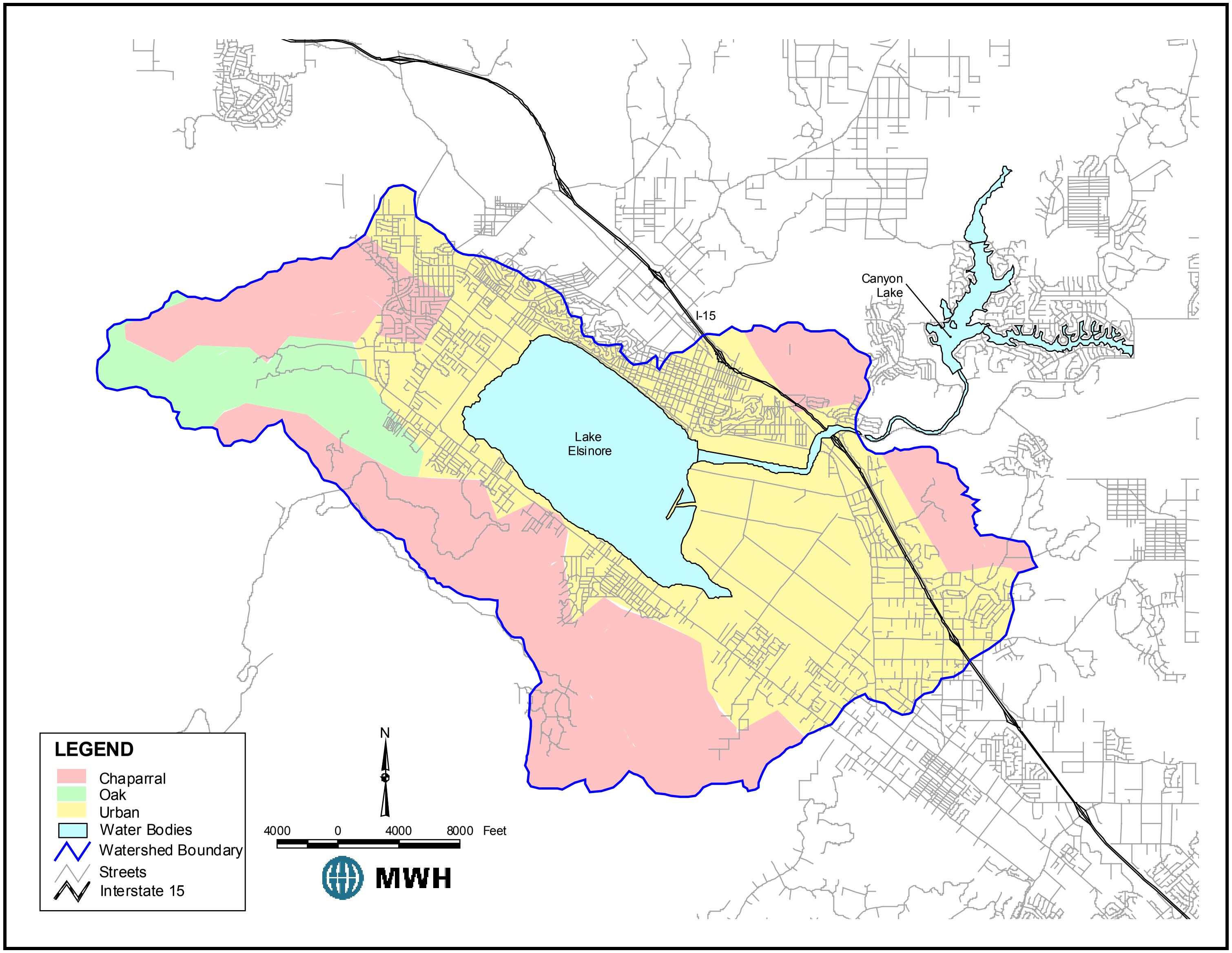
In general, precipitation that does not become runoff is utilized for soil moisture replenishment before infiltrating through the soil into groundwater. The evapotranspiration within the open space is estimated according to the method described by the DWR (2000). These estimates are provided in **Table 2-4**. With this method, the evapotranspiration is estimated by multiplying the reference evapotranspiration for the area by a landscape coefficient (K_L) for the specific plant community. According to the Riverside County Water Budget Formula (2001), the reference annual evapotranspiration value for Elsinore is 55 inches.

Table 2-4
Evapotranspiration Constants for Elsinore Basin

Plant	Water Needs Category	K_L	Landscape Evapotranspiration (inches)
Chamise Chaparral	Very Low	0.2	11
Canyon Live Oak	Low	0.3	17

During the base period (1990-2000), approximately 2,000 acre-ft/yr entered the groundwater basin in the open areas.

Figure 2-15
Vegetation Distribution in the Elsinore Basin



Source: Information Center for the Environment, UC Davis

Recharge from Precipitation in Urban Areas

The fate of precipitation on the urban areas in the Elsinore Basin is estimated by creating runoff coefficients for each of the subwatersheds in the basin. Land use data (see **Figure 2-16**) are used to calculate a weighted average percent imperviousness for each subwatershed. A runoff coefficient is calculated from percent imperviousness. Runoff is calculated by multiplying the precipitation over the subwatershed by the runoff coefficient. Evapotranspiration from the pervious areas of the watershed is subtracted from the non-runoff water and the remainder, if any, is infiltration to groundwater. It is assumed that plants in the urban areas would be irrigated. Therefore, only a portion of the plant evapotranspiration needs are fulfilled through precipitation.

Figure 2-17 presents estimated annual infiltration due to precipitation from 1990 to 2000. The average inflow during this time period is approximately 2,800 acre-ft/yr. It is important to note that significant recharge occurs in the wetter years. During drier periods, there is no significant amount of groundwater recharge from precipitation.

Surface Water Recharge

The principal surface water bodies in the Elsinore Basin are the San Jacinto River and Lake Elsinore. Recharge from these water bodies is derived from infiltration.

San Jacinto River

The San Jacinto River is the primary source of surface water inflow to the Elsinore Basin. **Figure 2-18** presents historical San Jacinto River stream flows since 1916 in stream gauge 1107050, located north of I-15. Since 1916, the average annual flow at the USGS stream gauge was approximately 19 cfs (13,700 acre-ft/yr). However, since Railroad Canyon Dam was constructed in 1927, substantial flow in this portion of the San Jacinto River only occurs when there are releases or spills from Canyon Lake. The San Jacinto riverbed is characterized by fine to medium sand and encompasses an area of approximately 51 acres (downstream of gauge 1107050). Assuming an infiltration rate of approximately 0.6 feet/day, the average annual inflow to the basin since 1916 is estimated to be approximately 1,240 acre-ft/yr or approximately 8 percent of the total flow in the river downstream of Canyon Lake. Based upon field observations and the location of the stream gauge, it is assumed that there is no underflow beneath the stream gauge.

Estimated annual stream recharge to groundwater for the base period (1990 to 2000) is shown in **Figure 2-19**. The average groundwater recharge from the San Jacinto River during this time period is approximately 1,700 acre-ft/yr. As with precipitation, most of the recharge to the basin occurs during wet years.

Figure 2-16
Land Use in Elsinore Watershed

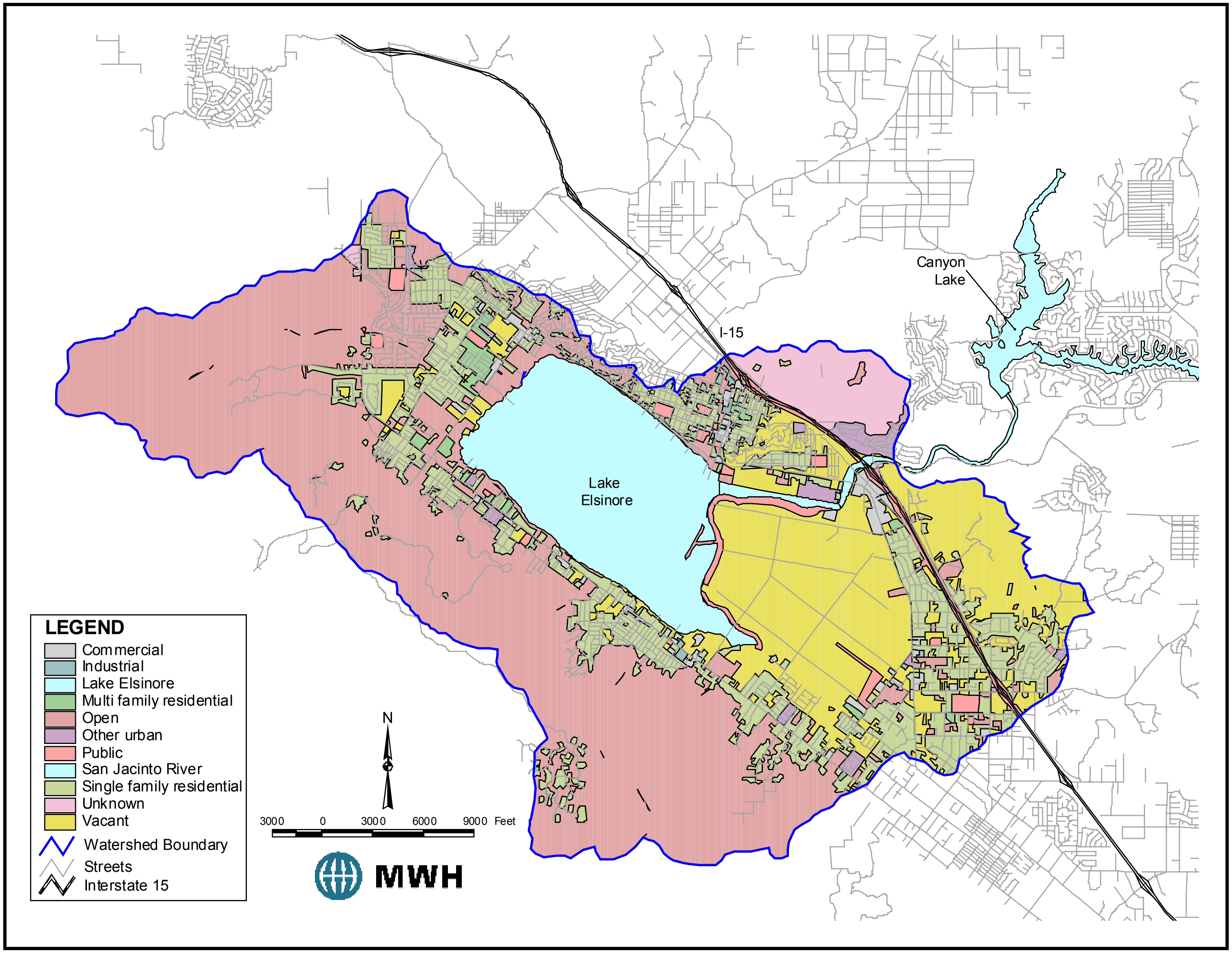


Figure 2-17
Annual Estimated Groundwater Recharge from Precipitation (1990-2000)

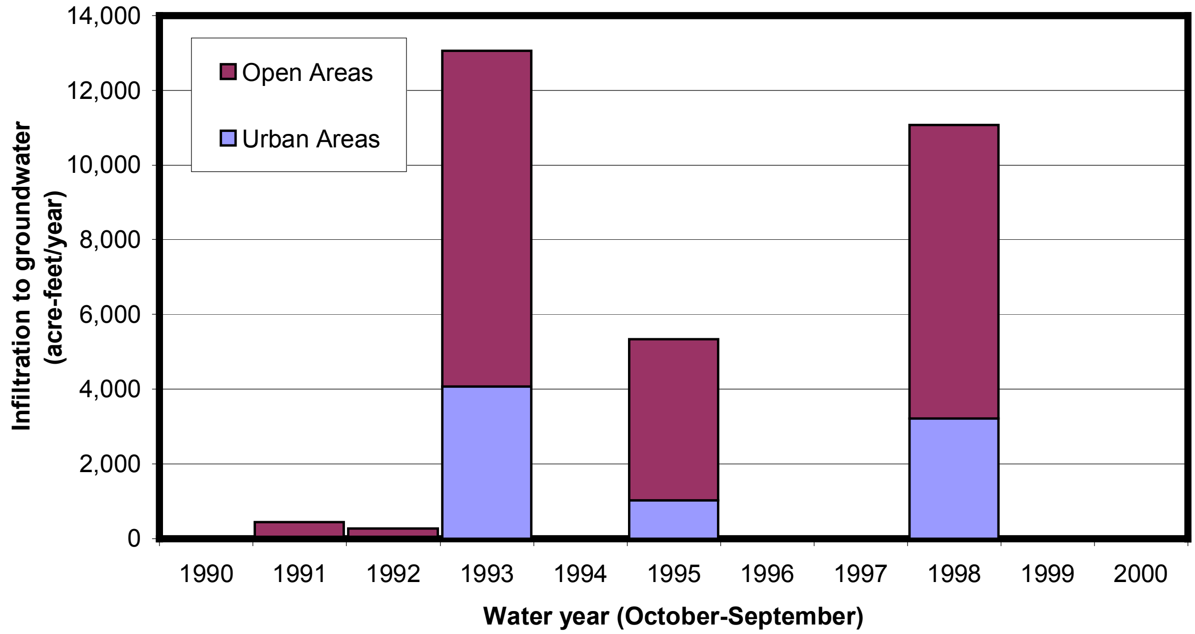


Figure 2-18
Historical Annual Streamflow at San Jacinto River (1916-2000)

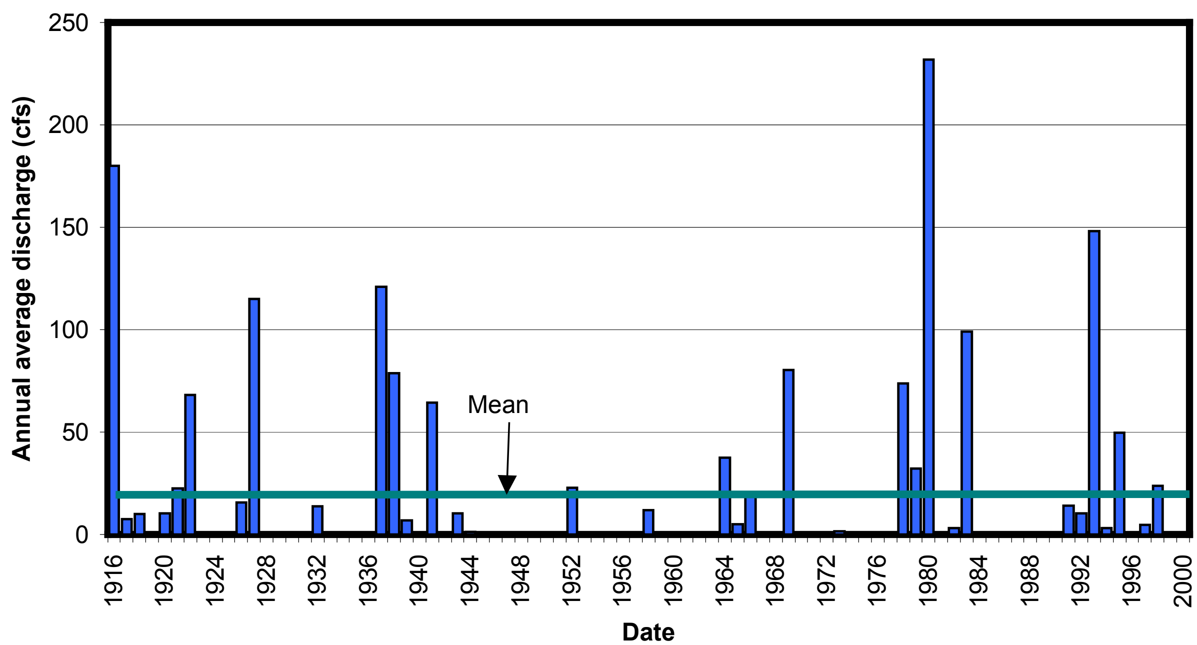
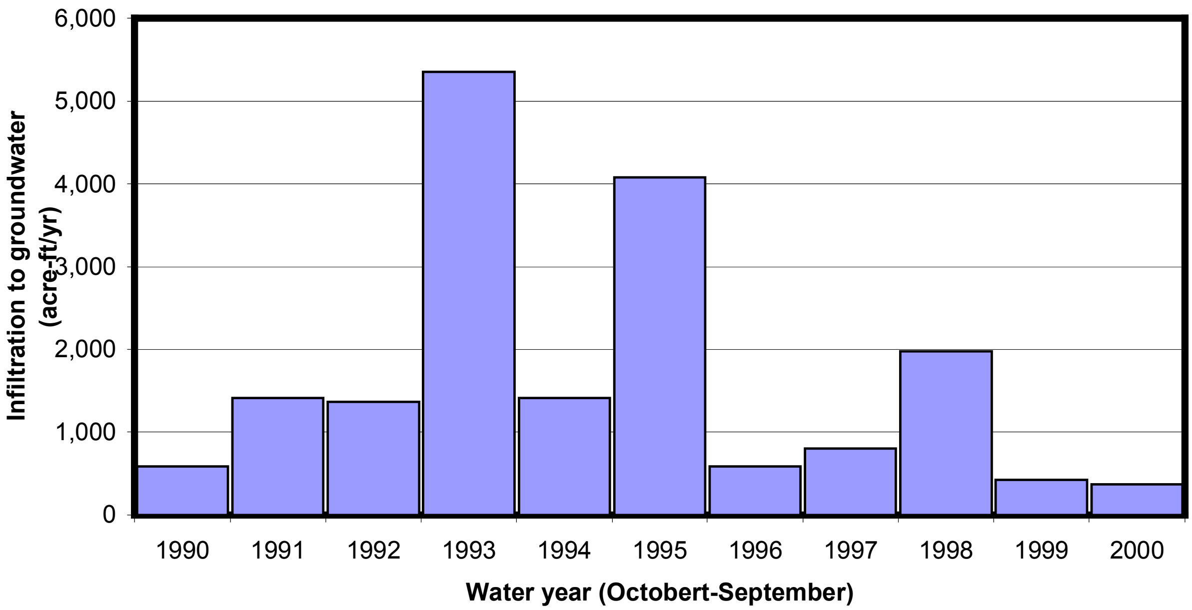


Figure 2-19
Estimated Groundwater Recharge from the San Jacinto River (1990-2000)



Lake Elsinore

Because of the predominance of clay beneath Lake Elsinore, it is assumed that Lake Elsinore itself does not contribute significant recharge to the groundwater basin and the net inflow from the lake is zero.

Recharge through Water Use

Groundwater recharge also occurs from applied water for landscape irrigation and infiltration from septic system leach fields. Each of these components is estimated below.

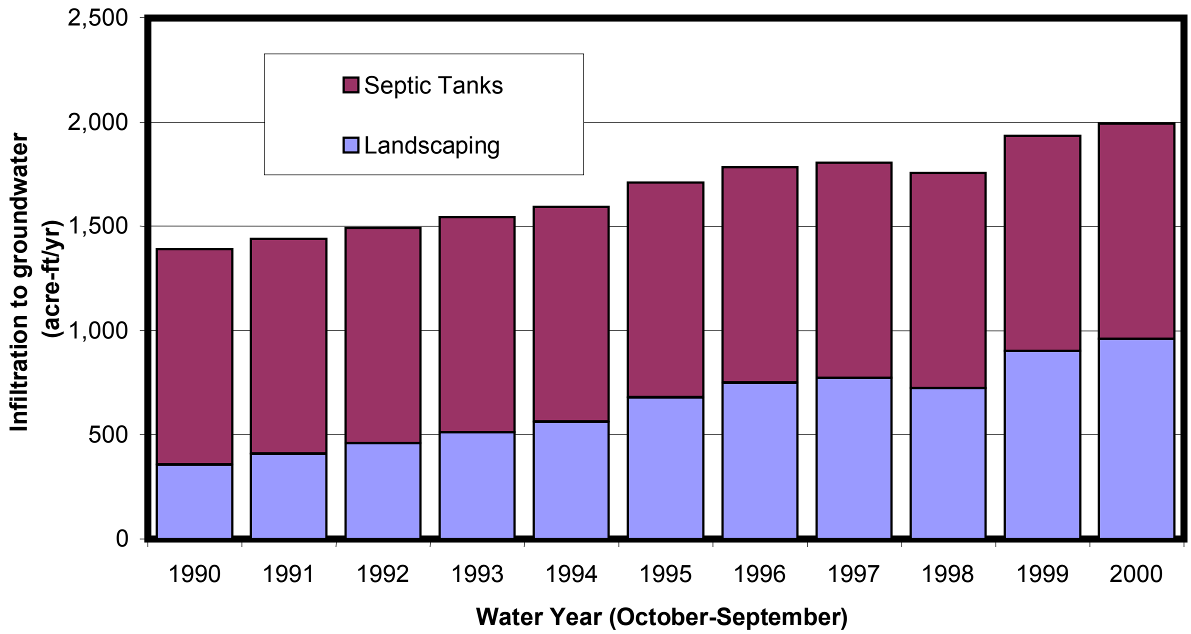
Applied Water

According to water production and usage data within the Elsinore Basin, approximately 39 percent of the water demand (2,500 acre-ft) in the area is used for outdoor needs, which generally consist of landscaping and irrigation (MWH, 2000). Because of the relatively dry climate and high water demands of most landscaping, the evapotranspiration requirement for landscaping within the Elsinore Basin exceeds 10,000 acre-ft/yr. Therefore, it is assumed that most of the applied water (in addition to most infiltration from direct precipitation) will be utilized by plants as evapotranspiration. Using a typical irrigation efficiency of 75 percent, an average of approximately 600 acre-ft/yr enters the groundwater basin from applied water. **Figure 2-20** shows the annual infiltration to groundwater through water use. As shown in this figure, the infiltration of irrigation returns has generally increased since 1990 because of the increase in demands throughout the basin. During wet years (e.g. 1998), less water was used for landscape irrigation so infiltration to the groundwater basin was also lower.

Septic Systems

EVMWD GIS data indicate that there are currently approximately 3,900 parcels within the Elsinore Basin that are connected to septic systems. Based upon an annual rate of approximately 0.25 acre-ft per tank, approximately 1,000 acre-ft/yr are added to the groundwater basin from septic systems. This inflow is expected to be relatively constant over the past decade because it is assumed that most new developments obtain connections to the sewer system and do not use septic systems.

Figure 2-20
Estimated Groundwater Recharge through Water Use (1990-2000)



In addition, some septic users have connected to the sewer system and some new septic users have been added in areas not served by the sewer system. Therefore, during this time period, it is assumed that the number of septic users has remained constant.

Subsurface Inflow

The Elsinore Basin is currently closed to underflow from outside the basin. Therefore, there is no subsurface inflow except as described above.

Outflows

The following are the major outflow components to the Elsinore Groundwater Basin:

- Evapotranspiration – the loss of groundwater from soil and open water bodies (e.g. Lake Elsinore) and transpiration by plants
- Groundwater pumping – groundwater extraction by wells in the basin

- Flow to surface water – flow from the groundwater basin to surface water bodies such as Lake Elsinore and/or Temescal Wash (i.e. rising groundwater)
- Underflow – subsurface outflow from the basin along the southeastern margin to Murietta

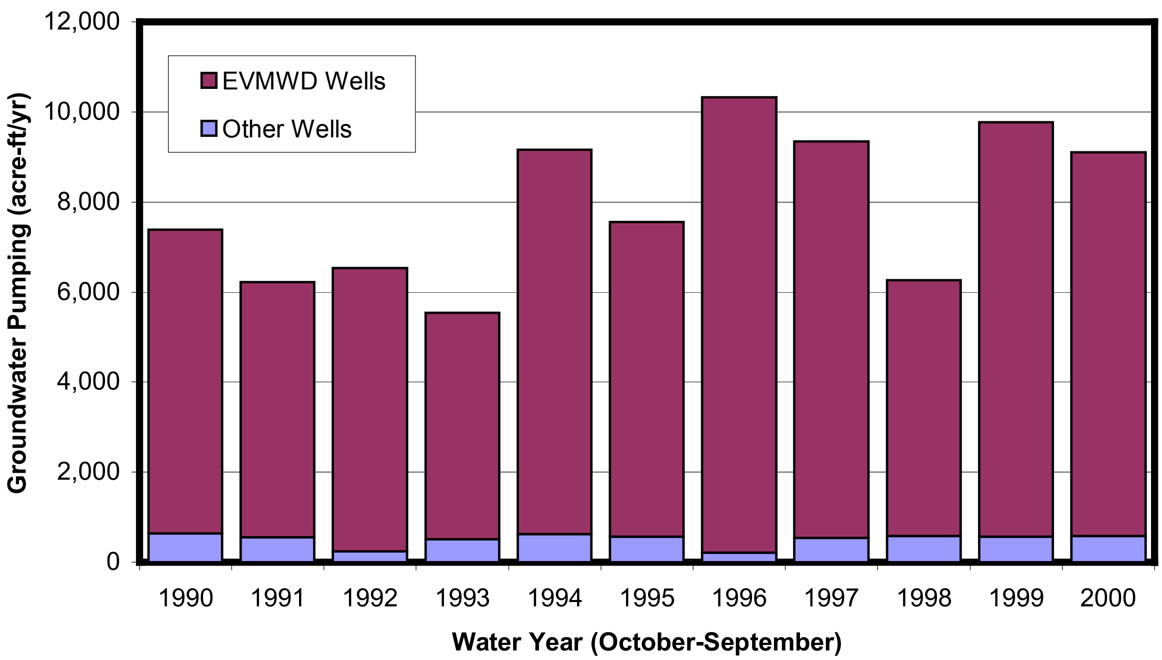
Evapotranspiration by Phreatophytes

Phreatophytes are plants whose roots extend to the water table and use groundwater directly for their water needs. Because groundwater levels are generally substantially below ground surface, it is unlikely that groundwater is currently lost to phreatophyte evapotranspiration. Therefore, this outflow term is zero. Evapotranspiration is considered when the infiltration from precipitation on urban and open areas is calculated.

Groundwater Pumping

Historical pumping data are summarized in **Figure 2-21**. These data do not include unmetered pumping from private well owners in the basin, thereby slightly underestimating the actual pumping. Private pumpers are believed to pump approximately 100 acre-ft/yr (assuming that each well pumps less than 1 acre-ft/yr).

Figure 2-21
Historical Groundwater Pumping in the Elsinore Basin



Surface Outflows

Because static groundwater levels are more than 100 feet below the level of Lake Elsinore, it is unlikely that significant groundwater is lost to the lake. However, in some locations in the Back Basin, there is perched groundwater at levels as high 10 fbgs. It is possible that this water could migrate toward Lake Elsinore. However, this water is limited in extent and would not produce significant outflows.

Subsurface Outflows

As discussed previously, the general groundwater flow direction is from the northwest to the southeast within the Elsinore Basin. Therefore, there is a potential for flow from the Elsinore Basin into the Murietta groundwater basin toward the southeast. As discussed previously, the bedrock surface rises up in the southeast to an elevation above current water levels, thereby preventing groundwater from leaving the basin. It is possible for water to be exchanged between the two basins if the water table rises to above an elevation of approximately 1,100 feet. However, if this situation were to occur, the potential flow is estimated to be less than 100 acre-ft/yr and is considered negligible.

Water Budget Summary

Table 2-5 presents the average groundwater budget for the base period from 1990 to 2000.

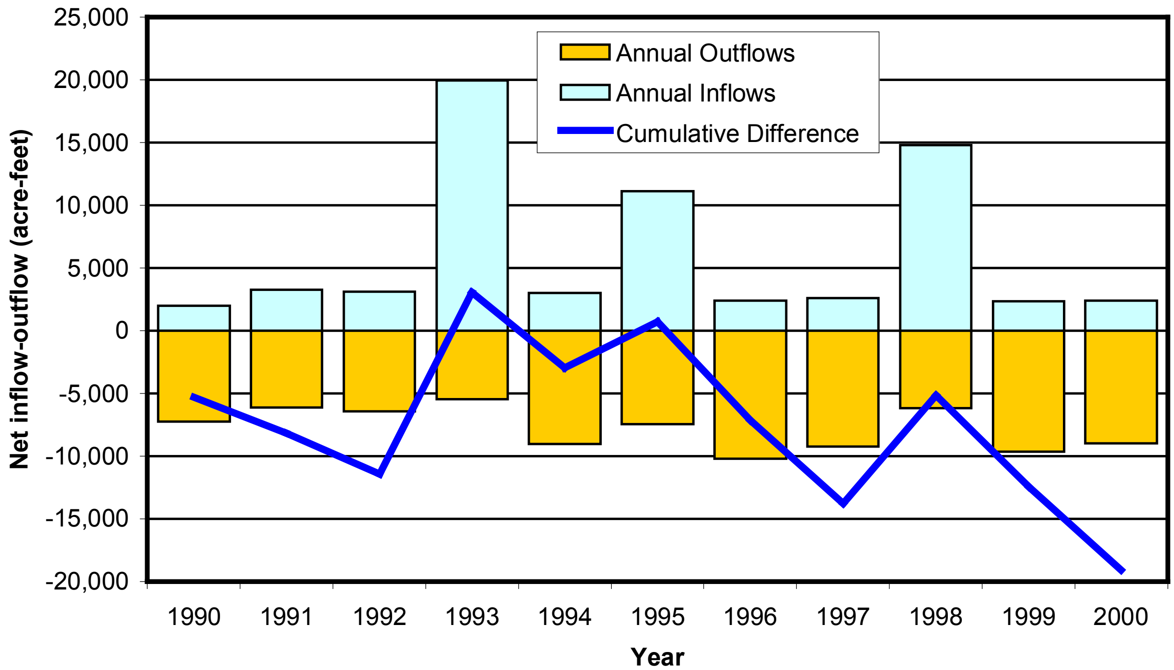
Table 2-5
Summary of Estimated Groundwater Basin Budget for 1990-2000

Component	Average (1990-2000)
Inflows	
Infiltration of Precipitation	
Rural Areas	2,000
Urban Areas	800
Recharge from Surface Water	
Recharge from San Jacinto River	1,700
Recharge from Lake Elsinore	0
Return Flows	
Applied Water	600
Septic Systems	1,000
Subsurface Inflow	0
Total Inflows	**6,100**
Outflows	
Groundwater Pumping	7,900
Surface Outflow	0
Subsurface Outflow	0
Total Outflows	**7,900**
NET SURPLUS/DEFICIT	**-1,800**

Based upon this period, the difference between inflows and outflows suggests an average annual groundwater deficit of approximately 1,800 acre-ft/yr over the 11-year period of review. **Figure 2-22** shows estimated annual inflows and outflows over the period. It is important to note that, during the period 1990 to 2000, the Elsinore Basin experienced a groundwater deficit in eight of the 11 years reviewed. The three years of positive balance were 1992-3, 1994-5 and 1997-8, which were very wet years. The estimated cumulative groundwater deficit in the Elsinore Basin between 1990 and 2000 was approximately 19,000 acre-ft.

These data are used to calibrate a groundwater flow model for the Elsinore Basin. Details on the model creation and calibration are provided in Section 3.

Figure 2-22
Total Estimated Inflows and Outflows to Groundwater Basin

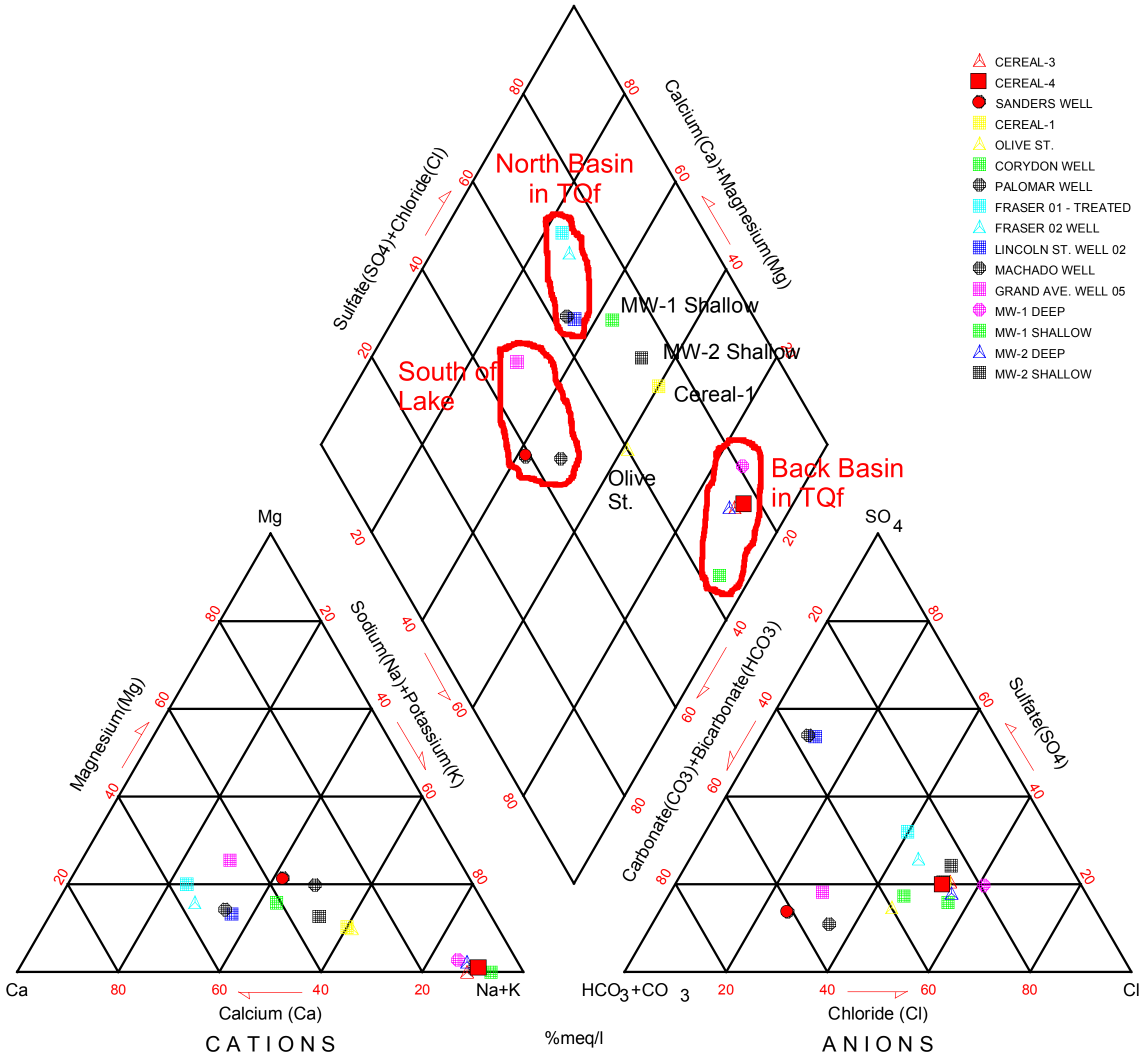


GROUNDWATER QUALITY

The following section provides a description of the groundwater quality within the basin as it relates to the hydrogeologic conceptual model.

Piper diagrams are often used to observe differences in general water quality from various sources. A Piper diagram plots various cation and anion concentrations on the same graph as a relative percentage, which allows for identification of water quality similarities and differences among various water sources that may not be detected simply by comparing concentrations. A Piper diagram for the Elsinore Basin is provided in **Figure 2-23**. These data suggest various water quality signatures throughout the basin. For example, the Cereal-1 well, which is screened across the alluvium and the Fernando Group, has an intermediate quality between the Corydon Well (which is screened only in the Fernando Group) and the monitoring wells that are screened in the alluvium. Similarly, the Lincoln Street Well and the Machado Well, which are screened in the Fernando Group and the Bedford Canyon Formation, appear to have similar water quality.

Figure 2-23
Piper Diagram in the Elsinore Basin



Time-series plots for total dissolved solids (TDS), nitrate and sulfate in select wells are presented in **Figure 2-24** through **Figure 2-26**. These constituents are often used to identify changes in water quality. General observations made from these data include:

- TDS (as well as nitrate and sulfate) is generally higher in the area north of the lake and along basin margins than in the Back Basin
- Highest concentrations of TDS, sulfate and nitrate are found at the Lincoln Street Well
- Lowest concentrations of TDS and sulfate are found in the Olive Street Well
- Nitrate (as nitrate) concentrations in the Palomar Well appear to be increasing

Figure 2-24
Historical Total Dissolved Solids Concentrations in Elsinore Basin Wells

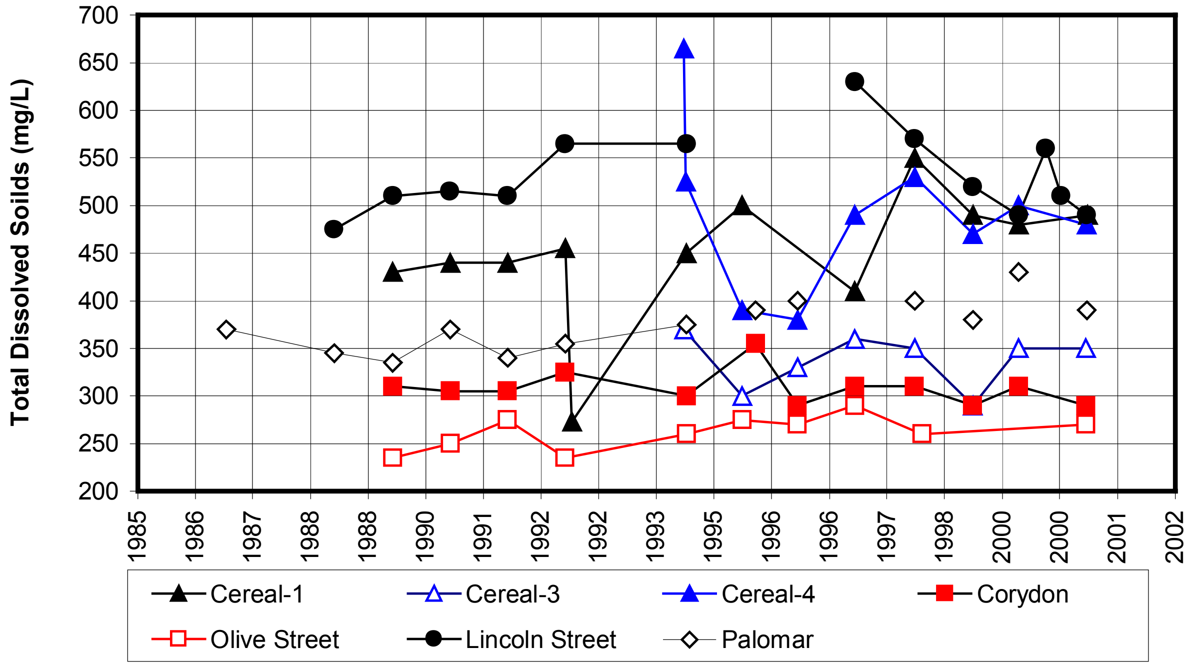


Figure 2-25
Historical Sulfate Concentrations in Wells in the Elsinore Basin

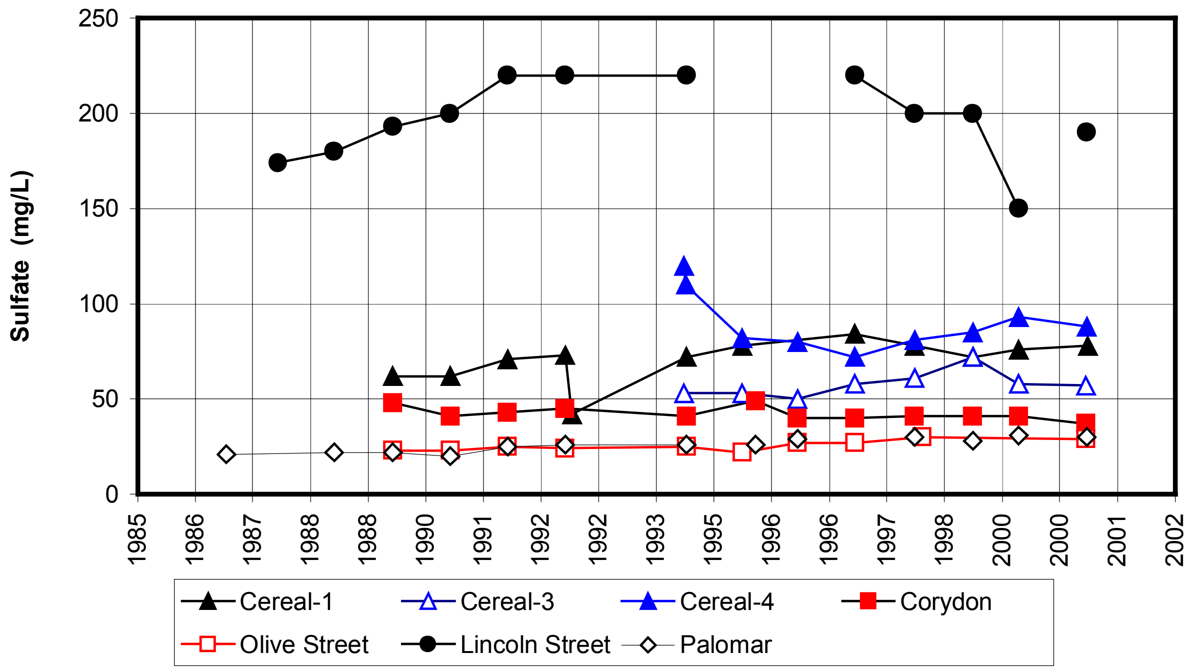


Figure 2-26
Historical Nitrate Concentrations in Wells in the Elsinore Basin

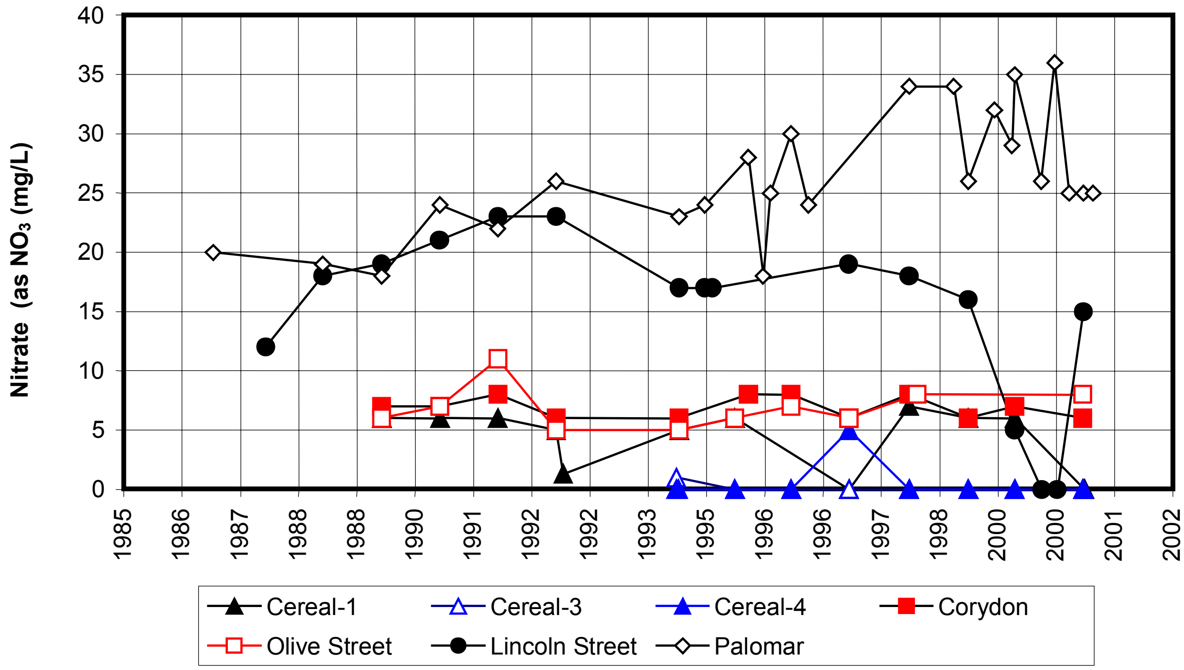
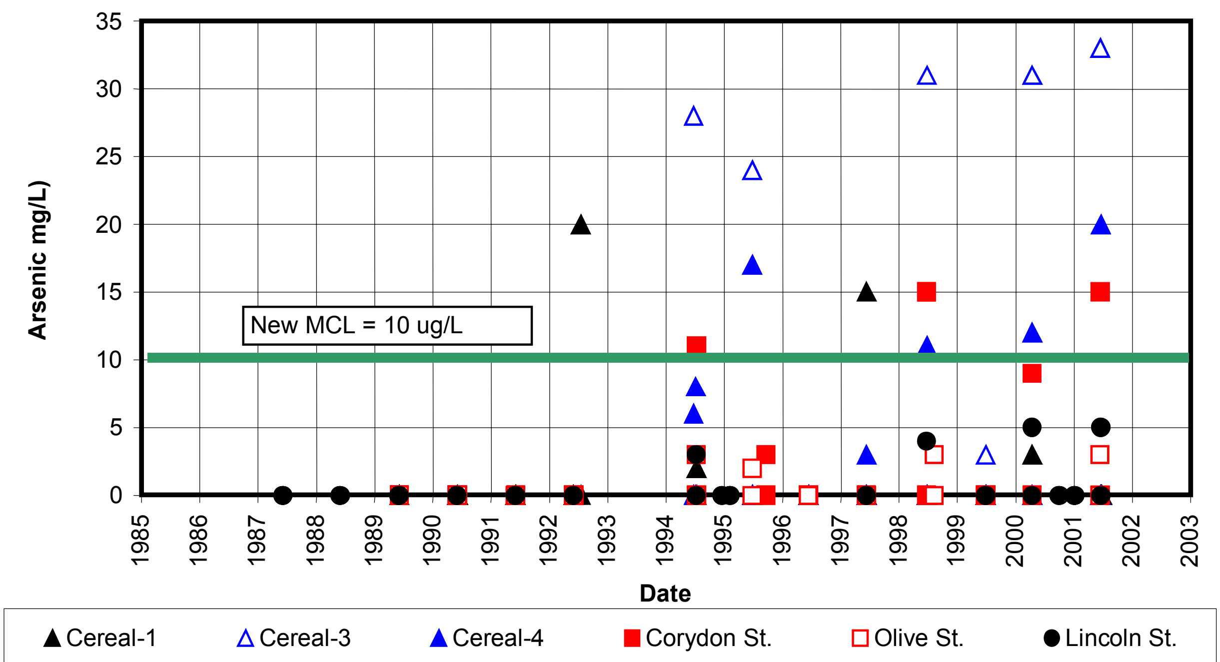


Figure 2-27
Historical Arsenic Concentrations in Elsinore Basin Wells



- Concentrations of arsenic are below the current standard of 50 µg/L, however, they have exceeded the new (effective 2006) maximum contaminant level of 10 µg/L in the Back Basin wells (Cereal-1, Cereal-3, Cereal-4 and Corydon Street)
- The highest concentrations of arsenic are found in deeper wells such as Cereal-1, Cereal-3 and Cereal-4

The higher concentrations of various constituents in the area north of the lake could be a result of historical land use practices in this area. Historically, much of the area north of the lake was an agricultural area. In addition, much of this area was on septic systems, which can result in higher nitrate concentrations in the groundwater. Wells such as Lincoln Street and Machado Street have higher nitrate and sulfate concentrations, which may be related to the prior land use in this area. Shallow wells in the area have also had historically higher sulfate and nitrate concentrations.

SUMMARY AND NEXT STEPS

Based upon the data compiled as part of this study, the conceptual understanding of the Elsinore Basin structure has been developed. The alluvium is separated from the Fernando Group by a confining to semi-confining aquitard throughout much of the basin, which restricts downward migration of groundwater into the Fernando Group. Recharge to the alluvium occurs along the margins of the basin through Leach, McVicker and Dickey Canyons and the San Jacinto River. Surface recharge to the Fernando Group is generally limited to the north end of the basin. Faults within the basin, except for the Glen Ivy fault and the Rome Hill fault do not appear to restrict groundwater flow, which allows recharge to occur within the basin.

Based upon vertical and lateral variations in water level throughout the basin, the following

- Water levels are generally declining in the Back Basin in both the alluvium and the Fernando Group
- Water levels are generally stable in the area north of the lake
- Water levels in the alluvium are generally higher than in the Fernando Group, which suggests the presence of a confining or semi-confining unit between the Fernando Group and the overlying alluvium.
- Groundwater flow is generally from the area north of the lake to the Back Basin

Lateral and vertical variations in water quality are also observed. General observations made from these data include:

- TDS (caused by higher nitrate and sulfate) is generally higher in the area north of the lake and along basin margins than in the Back Basin
- Highest concentrations of TDS, sulfate and nitrate are found at the Lincoln Street Well
- Lowest concentrations of TDS and sulfate are found in the Olive Street Well
- Highest concentrations of nitrate are found in the Palomar Well and these concentrations appear to be increasing.

The average groundwater deficit between 1990 and 2000 was approximately 1,800 acre-ft/yr. This estimate is generally consistent with the observed decline in groundwater levels during this time period in the Back Basin area.

These data are used as inputs to the numerical groundwater model, which is discussed in **Section 3**.

Section 3
Groundwater Model

This section describes the development of the groundwater model for the Elsinore Basin. This report includes:

- Model layer definition, including thickness and horizontal extent
- Geologic fault definition
- Aquifer parameters, including vertical and horizontal conductivity and storativity
- Results of model calibration.

The purpose of the groundwater model is for use as a groundwater resource planning tool. The model is able to quantitatively evaluate aquifer responses to induced stresses and proposed groundwater use scenarios.

MODEL CONSTRUCTION

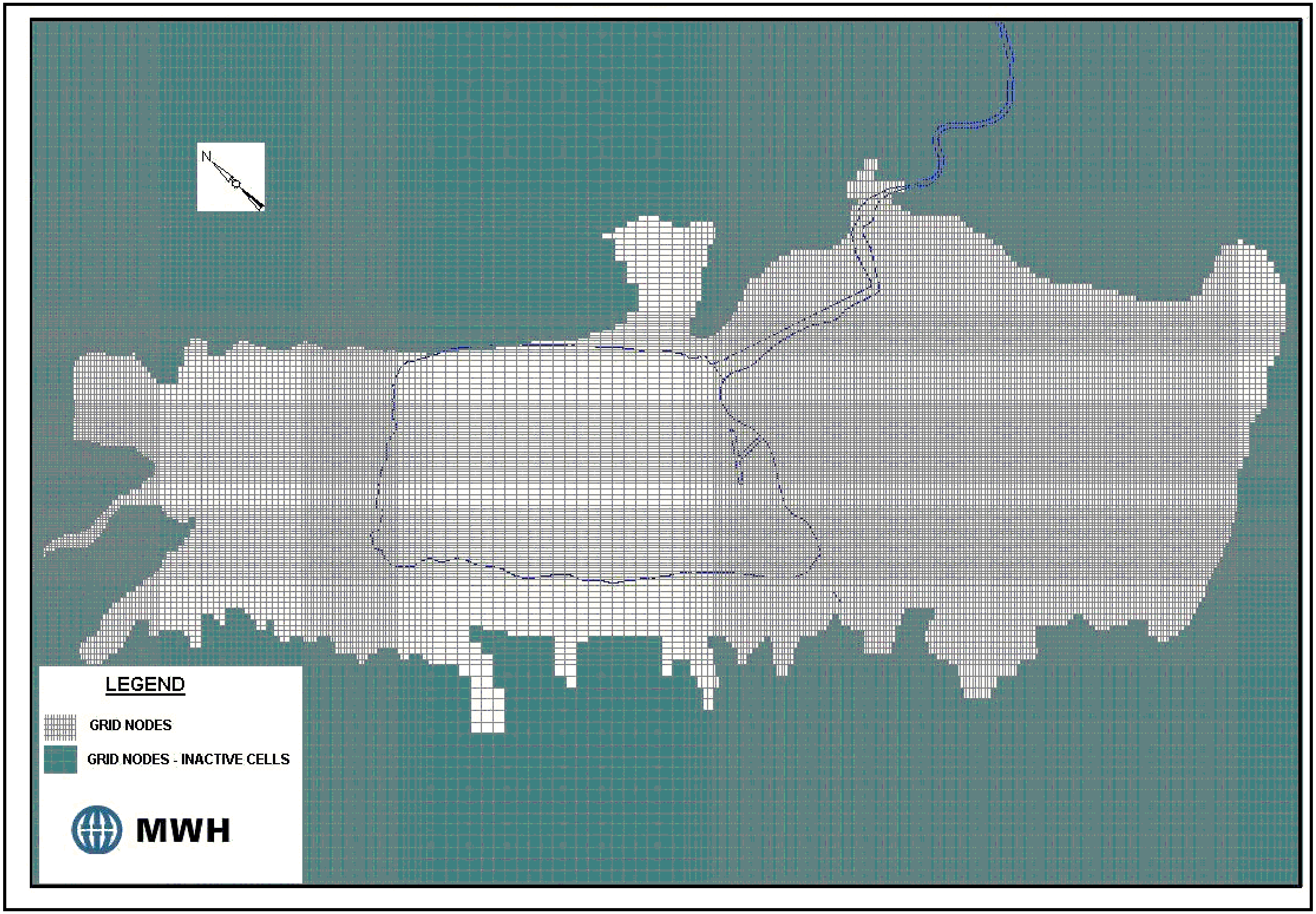
In general, a numerical model approximates groundwater flow conditions for a groundwater system based upon conceptual model aquifer parameters, groundwater flow conditions, and proximal groundwater quality. Flow model construction and calibration simulations are undertaken using Visual MODFLOW Pro 3.0 (Waterloo Hydrogeologic, 2002), a graphical interface to MODFLOW. Visual MODFLOW Pro is a commercially available, three-dimensional, block-centered, finite difference simulator of groundwater flow and contaminant transport. MODFLOW is an industry standard, numerical groundwater model developed by the United States Geological Survey (USGS). The model created for use in the Elsinore Basin does not include a water quality assessment. However, future updates of the model may include water quality assessments. This section describes the model domain, model layer discretization, aquifer parameters, boundary conditions, and hydrologic stresses.

Model Domain

The model domain, shown in **Figure 3-1**, is an area of approximately 80 square miles, of which approximately 25 square miles (white area) centered on Lake Elsinore are comprised of active cells located within the groundwater basin. Cells in the remaining area lie outside the groundwater basin boundary, and these are assigned inactive status during creation of the model.

The horizontal model domain is comprised of a grid of rectangular computational cells oriented with its principal axes coincident to the predominant direction of groundwater flow (northwest to southeast) within the basin. The dimensions of the domain are 36,880 feet perpendicular to the predominant groundwater flow and 60,340 feet parallel to the predominant groundwater flow direction. As mentioned previously, appropriate computational cells within the model domain are made inactive in areas outside the active groundwater flow system.

Figure 3-1
Model Domain and Grid Discretization



The active model domain is 26,320 feet perpendicular to predominant groundwater flow and 51,740 feet parallel to the predominant groundwater flow direction. The rectangular grid spacing varies, with areas of enhanced numerical interest (near pumping wells, faults, etc.) having grid dimensions of approximately 115 by 120 feet. Coarser grid spacing is present away from those regions, with maximum grid spacing approximately 480 by 460 feet. Overall, the active model grid is comprised of 98 rows and 311 columns.

The model is discretized vertically into four layers. However, all five hydrostratigraphic units present in the basin are represented in the model, as explained below.

Model Layer Discretization

Vertical discretization of the model layers reflects the conceptual model of the basin, which is discussed in detail in Section 2. The flow model of the groundwater basin is comprised of four model layers (see **Figure 3-2**), with hydraulic characteristics generally as follows:

- Layer 1 - shallow aquifer composed of alluvium (Qal) and Older Alluvium (Qt)
- Layer 2 – localized clay aquitard underlying the shallow aquifer (Aqt)
- Layer 3 – Fernando Group (TQf)
- Layer 4 – Bedford Canyon Formation (bcb)

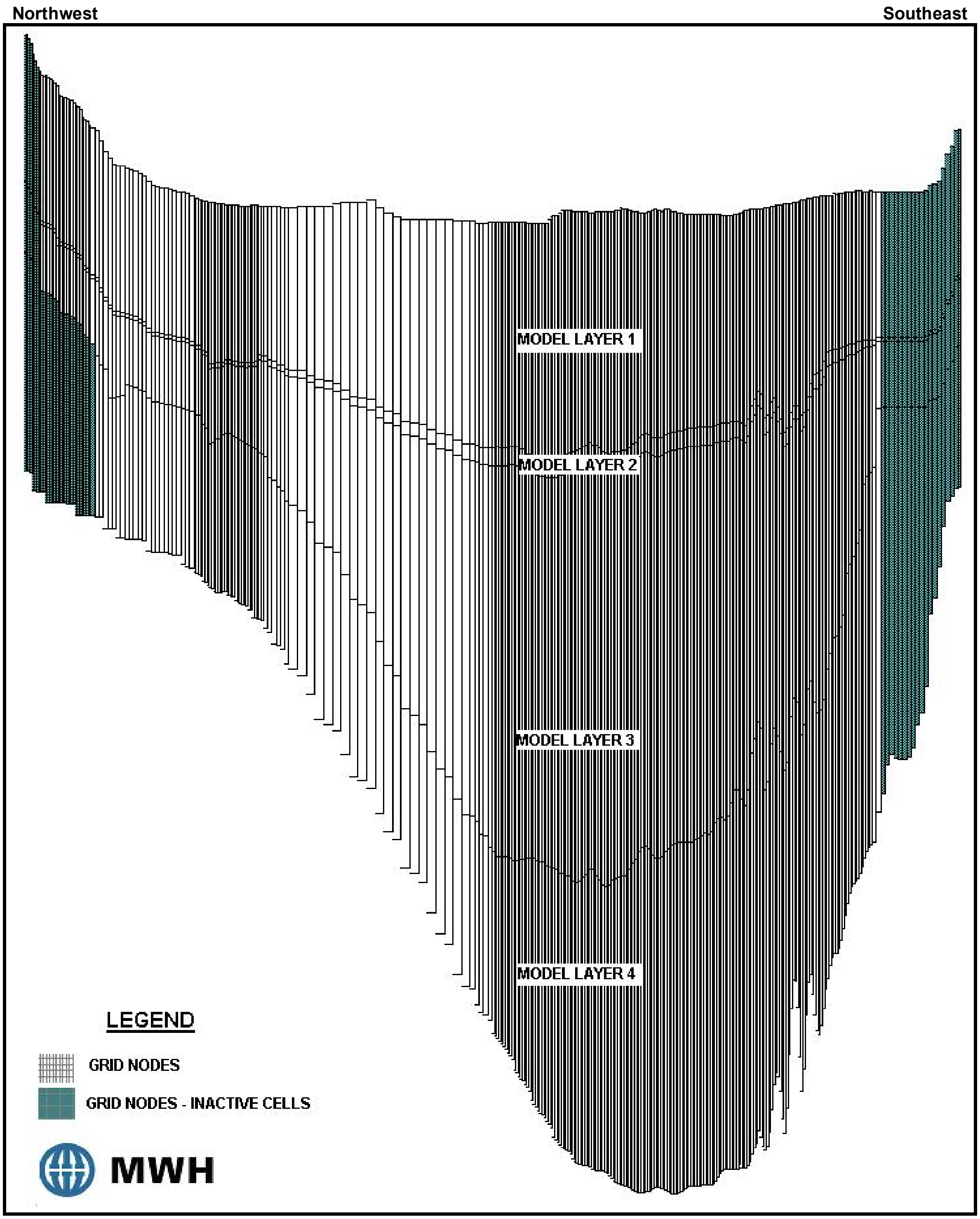
Figure 3-2 shows a longitudinal cross section through the model domain to illustrate the model layers. Model Layer 1, the shallow alluvial aquifer, is generally laterally continuous in the active model domain, except in the Back Basin area where the Fernando Group is exposed at the ground surface due to faulting. With similar hydraulic properties, the Qal and Qt map units (Section 2) are combined into undifferentiated alluvium (Qa) for modeling purposes. Comprised of interfingering sands and clays, the alluvium is second to the Fernando Group in importance as a source of groundwater supply in the basin. The thickness of this unit exceeds 300 feet in parts of the basin.

Model Layer 2, the clay aquitard, appears to be laterally continuous in the graben area defined by the Glen Ivy and Wildomar faults. However, outside the graben, the aquitard is typically not present. The aquitard thickness approaches 100 feet or more in the western part of the basin. Where the Fernando Group is found at the ground surface, the aquitard is locally absent. Water level data suggest that the aquitard, where present, is a confining unit to the underlying Fernando Group.

Model Layer 3, the Fernando Group (TQf), is composed of poorly sorted, granitic sands, cobbles, and boulders. With a saturated thickness approaching 1,200 feet in places, the Fernando Group is the most important source of groundwater in the basin. Due to the complex geologic structure and depositional history of the basin, including numerous faults and periods of erosion and/or non deposition, the Fernando Group is not laterally continuous in the basin. In general, the lateral extent, as ascertained from borehole data, is defined by the graben area between the Glen Ivy and Wildomar faults referred to previously.

Figure 3-2
Longitudinal Cross Section Through Flow Model

(vertical exaggeration 25X



Consequently, where the Fernando Group is present at the ground surface (due to faulting in the Back Basin area for example), its hydraulic properties are assigned to Layer 1 in that area even though Layer 1 is assigned hydraulic properties of the undifferentiated alluvium elsewhere. Likewise, in areas of the basin where the aquitard is thin or not present, such that alluvium directly overlies the Fernando Group, Layer 2 is assigned hydraulic properties pertaining to the Fernando Group even though in the remainder of the model Layer 2 is assigned hydraulic properties of the aquitard. This technique is also used as necessary to assign hydraulic properties of the undifferentiated granitic basement rocks to Layers 2, 3, and 4 outside the graben area.

Model Layer 4, the Bedford Canyon Formation (bcb), is described as interbedded slate and sandstone. It does not yield significant quantities of groundwater to wells. Like the Fernando Group, its presence appears to be largely fault-controlled. Therefore, in the model, the Bedford Canyon Formation is predominately found within the graben area between the two major fault systems (Rome Hill and Wildomar), except in the structurally complex Back Basin area (e.g. Rome Hill fault area). The base of the flow model is the base of Layer 4. Depending on the location within the model, Layer 4 is either assigned hydraulic characteristics of the Bedford Canyon or the undifferentiated basement rocks described below.

The base of the flow model in the area generally between the Wildomar and Glen Ivy faults is considered to be the top of the undifferentiated granitic basement rocks. Elsewhere the zone of hydraulic conductivity representing the basement rocks may be present in Model Layers 2, 3, or 4 where faulting or nondeposition of overlying units has juxtaposed alluvium with underlying basement rocks. While the hydraulic conductivity of the basement rocks is considered to be several orders of magnitude less than that of the overlying formations, the unit does yield small amounts of groundwater to wells where fractures or weathered zones are present.

The elevations of the bottom of model layers are based on cross sections A-A', B-B', and C-C ' found in Section 2 (**Figures 2-6 through 2-8**), as well as borehole data compiled by MWH. In addition, structure contour maps showing approximate elevations of the base of the four hydrostratigraphic units are generated using available borehole data (**Appendix C)**.

Naturally, fault-induced displacements of up to hundreds of feet can create challenges for any contouring algorithm that is used to generate layer bottom elevations as input to a model. For that reason, layer bottom elevations in the model should only be considered as rough approximations in areas where the geologic structure is complex, i.e. near the faults.

Based on Cross Section A-A' in Section 2 (**Figure 2-6**), the Fernando Group and Bedford Canyon Formation exhibit the greatest saturated thickness in the Back Basin area, specifically in the vicinity of the Cereal-3 and Cereal-4 wells. A representative longitudinal cross section showing the four layers of the model is shown in Figure 3-2. A four-layer model allows stresses to be simulated in a specific layer, as appropriate, given the completion depths of the extraction wells within the model domain.

Aquifer Parameters

Aquifer parameters are based upon data compiled as part of this investigation as described in **Section 2**. **Figure 3-3** shows the lateral distribution of hydraulic conductivity assigned to Model

Layer 1 (top of figure) and Model Layer 3 (bottom of figure), which are the primary water bearing formations in the basin. The color-coded zones correspond to different values of hydraulic conductivity (K) and storativity.

The white and green zones represent regions consisting predominately of alluvium; green, purple, and blue represent the Fernando Group; red indicates the Bedford Canyon Formation; and teal represents the undifferentiated basement rocks. Because the colors indicate similar hydrogeologic properties, colors in different zones may be the same. The spatial distribution in all layers, as well as the model input values, reflect data gathered from borehole logs, aquifer pumping tests, well specific capacity information, and values estimated from the literature.

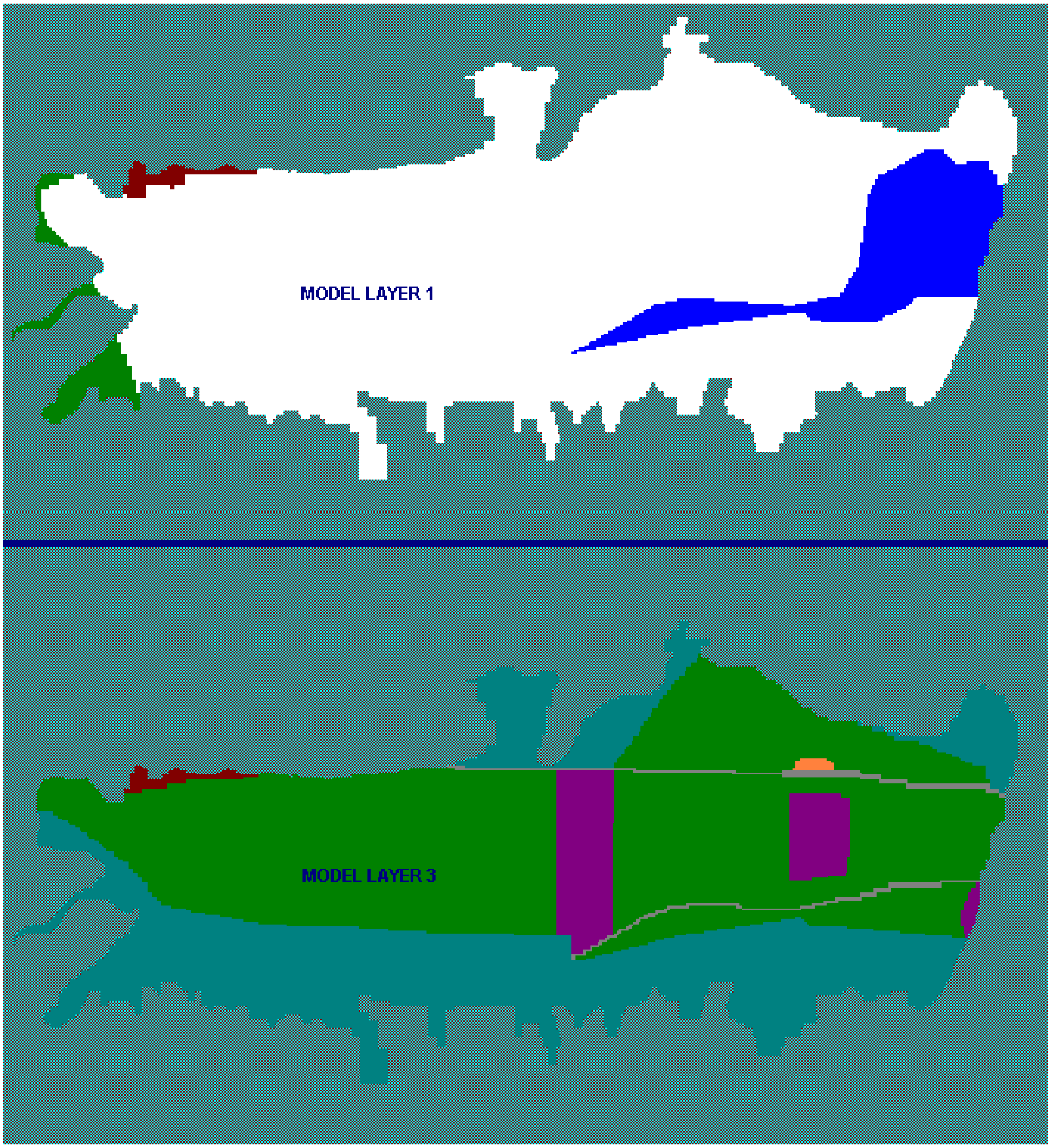
Other hydraulic characteristics that are assigned to the color-coded zones are explained below and are summarized in **Table 3-1.**

- Model Layer 1 is assigned a horizontal to vertical hydraulic conductivity (K_H:K_V) anisotropy ratio varying from 3:1 to 100:1. Isotropic horizontal hydraulic conductivity values are assumed.
- A horizontal to vertical hydraulic conductivity anisotropy ratio of 100:1 is used for Model Layer 2, reflecting the higher proportion of clays in the aquitard. Isotropic horizontal hydraulic conductivity is also assumed for this model layer.
- A horizontal to vertical hydraulic conductivity anisotropy ratio varying from 3:1 to 100:1 is used for Model Layer 3.
- Specific storage values ranging from 10^{-6} to 10^{-3} ft^{-1} are assigned to the various zones. For specific yield, values ranging from 0.05 to 0.20 are used, depending on the layer and formation represented.

Table 3-1
Aquifer Property Model Input Parameters

Hydrostratigraphic Unit	Model Hydraulic Conductivity			Model Specific Storage (1/ft)	Model Specific Yield	Model Effective Porosity
	Kx (ft/day)	Ky (ft/day)	Kz (ft/day)			
Alluvium	20 3.0	20 3.0	2.0 1.0	10^{-5} 10^{-5}	0.15 0.15	0.20 0.20
Clay aquitard	0.01 0.01	0.01 0.01	0.001 10^{-5}	10^{-6} 10^{-6}	0.05 0.05	0.05 0.05
Fernando Group	3.0 3.0 5.0	3.0 3.0 5.0	1.0 0.03 1.0	10^{-4} 10^{-3} 10^{-5}	0.1 0.1 0.2	0.10 0.10 0.2
Bedford Canyon Formation	0.5	0.5	0.1	10^{-6}	0.10	0.10
Undifferentiated Basement	0.001	0.001	10^{-5}	10^{-6}	0.10	0.10
Rome Hill and Willard Faults	0.001	0.001	10^{-4}	10^{-6}	0.10	0.10

Figure 3-3
Hydraulic Conductivity Distribution, Model Layers 1 and 3



Hydraulic Conductivity (feet/day)				
Color	Horizontal	Vertical	Geologic Formation Model Layer 1	Geologic Formation Model Layer 3
	20	2	Alluvium	N/A
	3	0.03	Fernado Group	N/A
	3	1	Alluvium	Fernando Group
	0.5	0.1	Bedford Canyon	Bedford Canyon
	0.5	0.1	N/A	Fernando Group
	5	1	N/A	Fernando Group
	0.001	0.00001	N/A	Basement
	0.001	0.0001	N/A	Faults
	N/A	N/A	N/A	Inactive Zone

MWH

Historical water level data suggest that the aquitard forms an effective hydraulic barrier between the alluvium and underlying Fernando Group. Hydraulic heads are typically higher in the alluvium. Many of the wells in the basin are completed into more than one aquifer, which masks the actual formation-specific head elevation at those locations.

Boundary Conditions

As summarized in the water budget discussion in Section 2, subsurface inflows and outflows of groundwater to/from the basin are insignificant due to physical boundaries present at the basin perimeter. As a result of the geologic structure, the basin is surrounded and underlain by essentially impermeable rocks. Therefore, except for occasional inflows from the San Jacinto River, the Elsinore Basin can be considered a closed groundwater basin. In the model, inactive cells are placed in the domain outside the groundwater basin boundary to simulate the physical barriers to groundwater flow . The basin boundary, therefore, is considered a no-flow boundary. In addition, a no-flow boundary is present at the bottom of Model Layer 4. No constant-head boundaries are used in the model.

Basin recharge (net of evapotranspiration) in the form of infiltration from precipitation, irrigation return flows, and septic system effluent are applied at variable rates in sixteen discrete zones over the entire active domain of the model (as described in Section 2). Each polygon is assigned its own set of monthly net recharge values. These sources of recharge are applied according to rates obtained from groundwater balance over a period of approximately 11 years (water year 1990 through water year 2000 as defined in Section 2). Inflows to the basin from the San Jacinto River are applied over the same time period in a discrete area of the riverbed within the model domain. San Jacinto River inflow is modeled using the recharge boundary condition within Visual MODFLOW. Lake Elsinore is not considered a significant source of recharge to the groundwater system.

Hydrologic Stresses

Groundwater is pumped primarily from the alluvium and Fernando Group at several locations within the groundwater basin. Groundwater extraction occurs primarily from municipal wells operated by the EVMWD and EWD, as indicated in **Table 3-2** and **Figure 3-4.** Total extraction volumes average approximately 7,900 acre-ft/yr between 1990 and 2000. Historical monthly extraction rates from the EVMWD wells are highly variable. Pumping rates in the Back Basin have slowly declined during 1990 to 2000 due to a decline in the potentiometric surface in the Back Basin. Regional groundwater flow inside the basin is toward the southeast (toward the Back Basin area) where several water district wells are clustered.

Table 3-2
Summary of Wells in Flow Model

Well Identification	Water Bearing Formation	Type of Well	Used in Calibration?
Cereal 1	Alluvium and Fernando Group	Pumping	Yes
Cereal 3	Alluvium and Fernando Group	Pumping	Yes
Cereal 4	Alluvium and Fernando Group	Pumping	Yes
Corydon	Fernando Group	Pumping	Yes
Lincoln #2	Fernando Group and Bedford Canyon	Pumping	Yes
Olive St	Fernando Group, Bedford Canyon and Basement rocks	Pumping	Yes
Palomar	Fernando Group	Pumping	Yes
Fraser #2	Fernando Group	Pumping	No
Grand Well	Not available	Pumping	No
Sanders Well	Basement rocks	Pumping	No
Showboat	Alluvium	Pumping	No
Wood Street #2	Alluvium and Basement rocks	Pumping	No
Wood Well	Alluvium and Basement rocks	Pumping	No
North Island	Fernando Group	Non-pumping	Yes
South Island	Fernando Group	Non-pumping	Yes

MODEL CALIBRATION

Within Visual MODFLOW, the user has a choice of five mathematical solvers that can be used to calculate the series of equations developed during solution of the groundwater model flow simulation. For groundwater flow simulations performed during model calibration, the Waterloo Hydrogeologic Software (WHS) numerical solver is used to calculate simulation results. The WHS Solver is an iterative, bi-conjugate gradient routine that solves the large system of equations using both inner and outer iteration levels. Overall, the WHS solver is found to be stable and accurate in its solution of the sets of equations to be solved by the problem posed.

Because of the complexity of the basin and interactions of the faults and uncertainty in the data, the model is considered calibrated if calculated heads are within 100 feet of the actual heads for key wells and matched the overall water level trends over the calibration period.

Figure 3-4
Calibration and Pumping Well Location Map

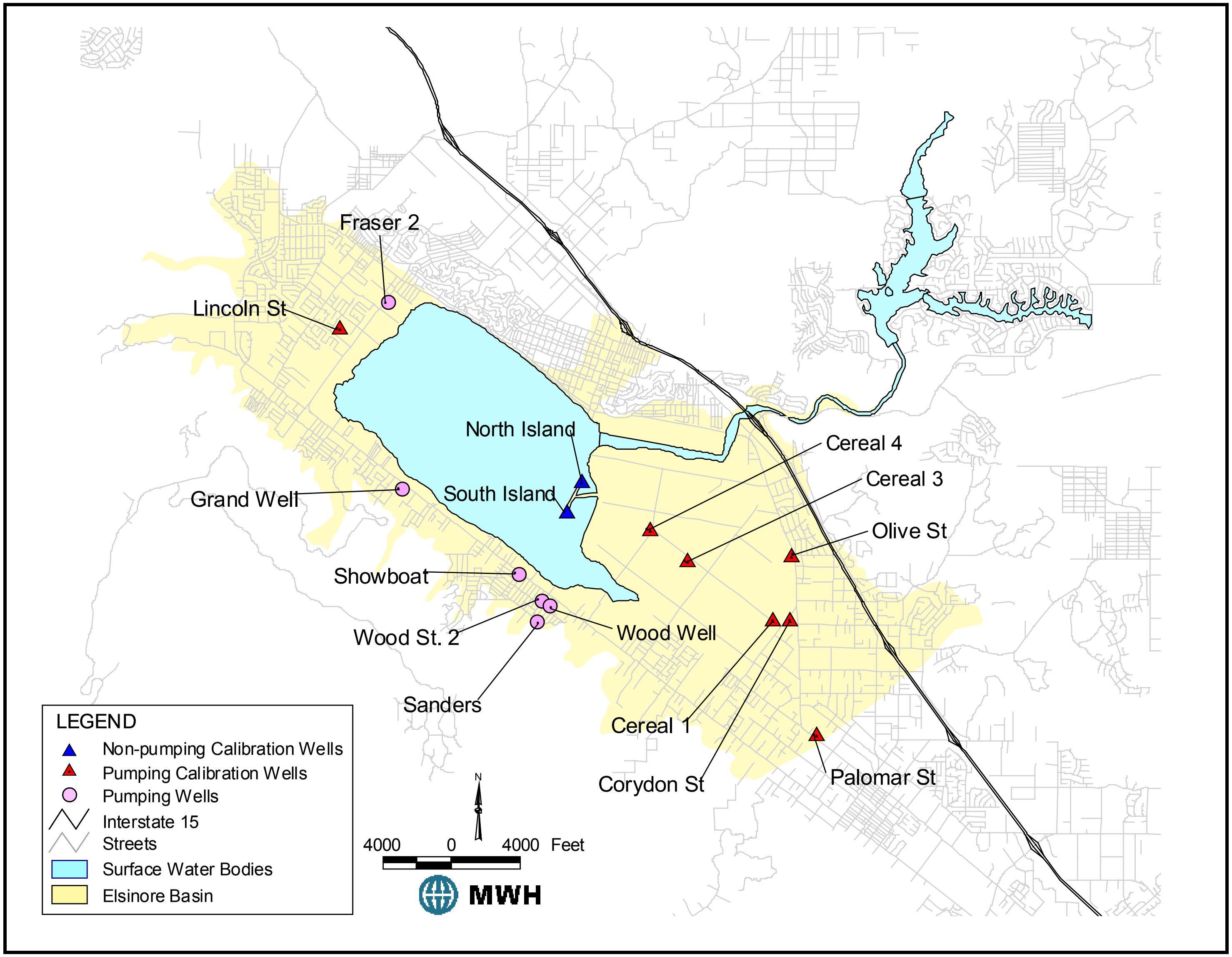
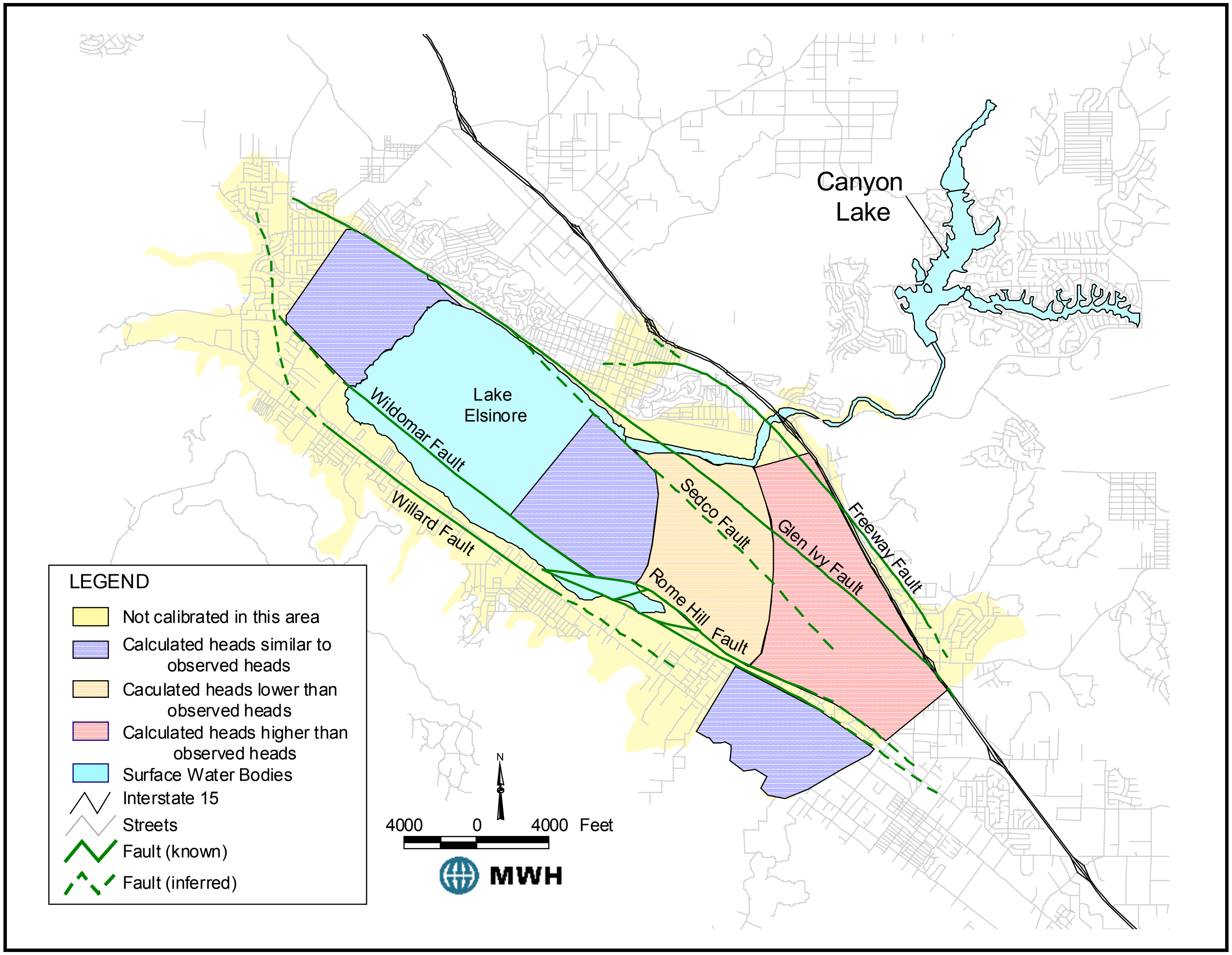


Figure 3-5
Relative Goodness of Fit for Groundwater Model



Calibration Wells

The seven EVMWD municipal wells listed in **Table 3-2** are used as calibration wells in the model. Measured water levels under pumping and static conditions comprised the calibration target values. In addition, the North Island and South Island wells are used as calibration wells in the model. The locations of wells utilized for model calibration as well as other pumping wells in the basin are shown in **Figure 3-4**.

Results

Calibration results for the calibration wells in Layer 3 are provided in **Appendix D**. The use of pumping wells for calibration purposes complicates calibration evaluation because of error induced by numerical limitations. In Visual MODFLOW, the extracted volume of groundwater is spread over the entire horizontal computational cell, thereby damping the numerical response of the model to changes in pumping rates. For example, measured pumping heads may decrease faster than calculated heads when increasing the extraction rate of a well. Conversely, measured pumping heads may increase faster than calculated heads when decreasing the extraction rate of a well. During model simulations, extraction rates are varied instantaneously on a monthly basis. Because of these numerical limitations, calibration plots at the non-pumping North and South Island wells are closely monitored as the best approximation of model calibration.

Appendix D also presents model calibration plots of calculated versus observed head (static and pumping) data for 1990 through 2000 and for individual years 1991 through 2000. The figures show that calibration improves with the later years, likely corresponding with an improvement in observed data quality. To verify that the groundwater model is predicting the same groundwater deficit as is presented in the conceptual model, a mass balance is calculated and evaluated for the entire model domain. The overall mass balance for the calibration period is shown in **Appendix D**. Overall, the water mass balance calculated by the model closely matches with the water budget presented in the conceptual model (Section 2).

Calibration plots are presented for wells going from northwest to southeast. A brief summary of calibration results for each well follows.

Lincoln Street Well

Calculated head levels are shown to change with variation in pumping rate and recharge. However, because the actual static levels increase with time and the pumping levels decrease with time, it is difficult to ascertain the actual trend in this area of the basin based upon the trend of Lincoln Street. In addition, reliable data are not available for this well prior to 1992. Based upon data from other wells near the Lincoln Street well (e.g. Machado Street well, Fraser 2 and Wisconsin well), the water levels appear to be relatively stable in this area. Therefore, the trend in water levels predicted for the Lincoln Street Well appears to be consistent with observed data.

North Island Well

Calculated head levels closely match observed static head data. The North Island well is a non-pumping well and provides more reliable calibration data for the basin. Data are not available for this well from early 1990 through 1992. Calculated heads for this well do not match observed trends particularly well during the El Nino event of 1992-93. This may be due to a variety of factors including: construction of the lake levee in 1995 that changed the hydrology of the basin or underestimating the amount of groundwater recharge based on averaging the El Niño rainfall event over the six month stress periods in 1993/94. However, the calculated data match well with the observed data post-1995. Therefore, the model appears to be well calibrated in this area of the basin.

South Island Well

Calculated head levels closely match observed static head data. The South Island well is a non-pumping well and, like the North Island well provides reliable calibration data for the basin. Data are not available for this well from early 1990 through 1992. Like the North Island well, calculated heads for this well do not match observed trends particularly well during the El Niño event of 1992-93. The calculated data match well with the observed data post-1995, however. Therefore, the model appears to be well calibrated in this area of the basin.

Cereal 4 Well

The trend of the calculated heads closely match the trend of the observed data. Calculated head values generally deviate less than 20 feet from observed pumping head data. This well was constructed in 1991 so limited data are available prior to 1992. Since 1995, calculated trends track well with observed trends.

Cereal 3 Well

The trend of the calculated heads closely match the trend of the observed data. Calculated head values generally deviate less than 30 feet from observed pumping head data. This well was constructed in 1991, so limited data are available prior to 1992. Since 1995, calculated trends track well with observed trends, although calculated water levels are generally lower than the observed water levels.

Cereal 1 Well

Calculated heads match the observed trend and are generally lower than static levels and higher than pumping head levels. The trend in this well is difficult to match because this well is used as a standby well and does not operate continuously during the month. For modeling purposes, an average monthly pumping rate is assumed, which results in higher head levels than observed. However, the trend is matched more closely after 1997 when this well was used more frequently and the average monthly pumping is more representative of the pumping from this well. Therefore, although the calculated heads do not match exactly with the observed heads, it appears to match well with the overall trend in the basin.

Corydon Well

The calculated heads for the Corydon well are generally higher than the observed heads by more than the 100-foot criterion. Repeated attempts to match data at the Corydon well have been unsuccessful. It is unclear if this is because of unknown geologic heterogeneity or if the measured data are suspect. Because the Corydon well is close to a fault boundary (Sedco fault) and the southern edge of the groundwater basin, it is difficult to determine if there may boundary effects that may impact the ability to calibrate to this well. In addition, the difference between observed static and pumping levels is relatively low and is not consistent with pump test data for this area. This suggests that the well may not be completely recovered when static water levels are taken and that the water levels recorded are largely dependent upon when the water levels are taken. This uncertainty makes calibration in this area difficult.

Olive Street Well

The measured pumping and static head data for the Olive Street well vary considerably, often by 200 feet or more during singular gauging events. Calculated variations between pumping and static data match this trend. Because the Olive Street well has been off-line for bacterial problems, it is used on an infrequent basis, which results in the large variations in water levels. Because of this, it is difficult to calibrate to absolute water levels for this well. Rather, trends in the data and fluctuations between on and off cycles are used to determine suitability of fit. Overall, the calculated head values generally match this fluctuation. However, like the Corydon Street well, this calculated heads are generally higher than the actual pumping heads.

Palomar Well

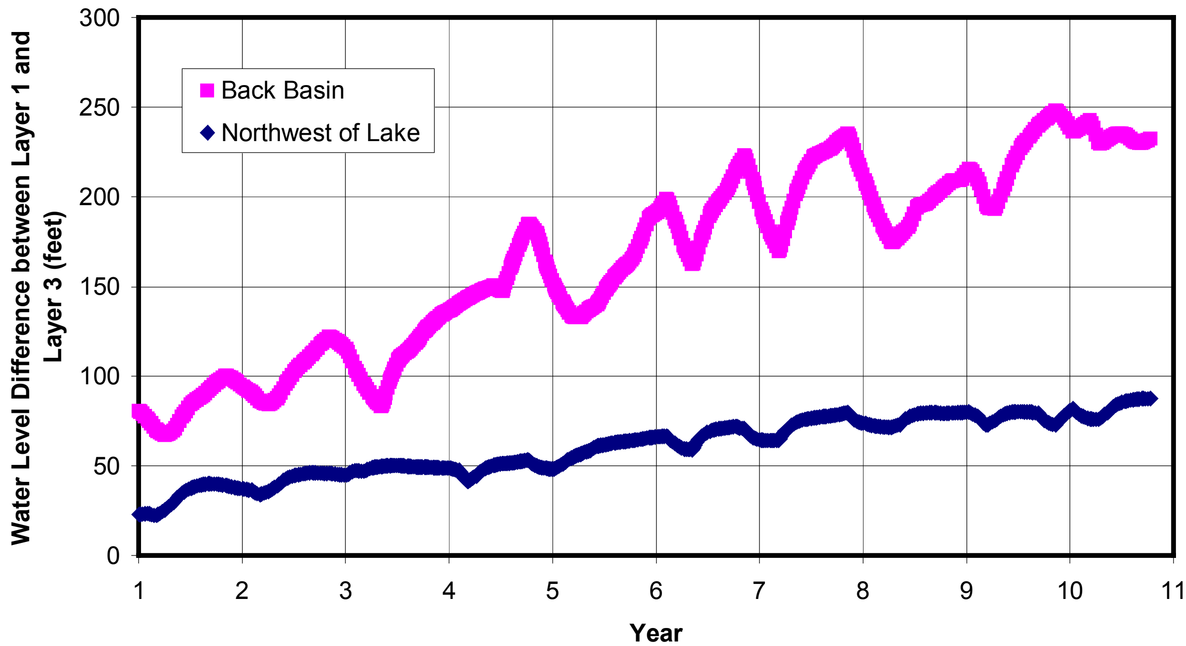
Calculated heads generally match the decreasing trend and values of the observed data. This area is generally well calibrated.

Calibration Analysis

A summary of the goodness of fit for the model area is provided in Figure 3-5. This figure shows the relative calibration error in qualitative terms. Where limited calibration data are available such as the margins of the basin, south of and beneath Lake Elsinore (areas shown in yellow), caution should be exercised in interpreting modeling results. In general, the model performs relatively well in the northwest portion of the basin, near the Island wells, and in the southeast portion of the basin near the Palomar well and differences in the calculated heads and the observed heads are generally much less than the 100-foot criterion. In the area between Cereal-4 and Cereal-3 in the Back Basin, calculated heads are generally lower than the observed heads. On the other hands, calculated heads are higher in the area east of Cereal-1. This area will need to be evaluated further.

Because of a lack of data available in the alluvium (Layer 1) for comparison over the calibration period, it is difficult to discern the accuracy of the groundwater flow model in the alluvium. As discussed in Section 2, the difference in head between the alluvium (Layer 1) and the Fernando Group (Layer 3) is on the order of 200 feet in the Back Basin area. In the northwest part of the basin, this difference is less. As shown in the contour map provided in **Appendix D** and the head summary shown on **Figure 3-6**, the calculated head in Layer 1 is generally consistent with these observations.

Figure 3-6
Modeled Difference in Water Level Between Layer 1 and Layer 3



Additional monitoring well data in the alluvium will be needed to calibrate the head changes in Layer 1.

Sensitivity Analysis

During model calibration, the sensitivity of the model results to variations in key parameters (e.g. definition of faults, aquifer parameters, pumping rate, recharge rates) are evaluated.

In the Back Basin area, the model is very sensitive to whether the Glen Ivy and Rome Hill faults are simulated to restrict groundwater flow. At one extreme, simulating these faults as not restricting flow results in inaccurate calculated head levels at the following wells: Olive Street, Corydon, and Cereal 1. Calculated heads in Corydon Street and Cereal-1 are on the order of 100 to 200 feet higher when the faults are not modeled as barriers than if they are modeled as barriers to flow.

Water levels in the Back Basin area are less sensitive to other parameters such as hydraulic conductivity or storativity. Calibration simulations in other portions of the basin show that the model is moderately sensitive to the magnitude of storage parameter specified. As is the case with many transient models, storage parameters are obtained from the literature for each specific soil/rock type and are adjusted during calibration runs.

Because most of the available calibration data is obtained from pumping wells, model calibration is extremely sensitive to assigned extraction or injection rates. During model calibration, pumping rates are averaged and assigned as monthly values. This averaging introduces error into calculated head values because the instantaneous pumping rate is not used. Due to the use of the pumping wells as calibration points, any deviation in modeled pumping rate from the actual instantaneous rate would result in a difference in calculated head and measured head data. Even for a properly calibrated model with minimal geologic uncertainty, the use of pumping wells to evaluate model calibration is fraught with difficulties.

Except along the margins of the basin, the model is minimally sensitive to net recharge. Recharge input is “averaged” both temporally and spatially over a 6-month period, which attenuates peaks and valleys in net recharge that enters the groundwater flow domain. Spatial averaging occurs by the use of rainfall, runoff, and septic data on a subregional basis. The overall effect is that net recharge input is “smoothed.” Therefore, peaks in data would not be captured but the overall trend would be observed. In this regard, the model would only be minimally affected. Future data input that includes recharge specification on a more refined temporal and spatial basis would likely result in improved model response.

Summary

Overall, model calibration is strongly impacted by sparse hydraulic head data of questionable quality and the use of pumping wells as calibration points. Because of the aforementioned limitations, this model should be considered a qualitative predictive tool, useful in the evaluation of aquifer trends in response to aquifer stresses. In order to use the model as a quantitative predictor of absolute aquifer head values, more site hydraulic head data should be collected and used to perform a post-audit of model accuracy.

MODEL LIMITATIONS

The availability and accuracy of site physical data limit computer models. Some limitations of the model are presented as follows:

- The model strives to simulate discontinuous water-bearing formations with widely varying hydrogeologic properties. Due to the complex geology and extensive faulting present in the basin, it is impractical for the model to capture all geologic heterogeneity. Limited site data available during model development does not allow for incorporation of all such possible features.

- With the exception of the Fernando Group, sparse aquifer pumping test data (for determination of hydraulic properties) are available for the hydrostratigraphic units. Consequently, model input hydraulic characteristics for the alluvium, aquitard, Bedford Canyon Formation, and basement rocks are estimated using appropriate values, which are then adjusted during model calibration.

- The limited number of calibration wells (nine) within the 26,320 square foot groundwater basin limits the evaluation of model calibration. Sufficient data over the calibration period is not available for the alluvium formations.

- Some wells have screens across multiple water-bearing formations. This complicates model calibration because it is difficult to determine how much of the flow comes from each formation prior to calibration.

Although the groundwater flow model has inherent limitations, it can be effectively used to predict general trends in aquifer reaction to pumping stresses. Site data is limited; however, data is sufficient in number and accuracy to calibrate the model for use as a predictive tool of aquifer general trends for basin-wide alternatives analysis. Among other uses, the model can be expected to be a good predictive tool to evaluate general trends for proposed groundwater recharge scenarios. However, it should not be used to evaluate site-specific water level variations or be used to evaluate absolute water levels.

The model can be used effectively to evaluate different groundwater recharge scenarios in fulfillment of development of this GWMP. The groundwater model presented herein is a good predictive tool for analysis of aquifer response to induced stresses in the groundwater basin and proposed groundwater use scenarios.

Future updates may be necessary based upon information collected through implementation of the GWMP. In particular, additional groundwater information that is gathered from monitoring wells in the alluvium and the Fernando Group should be included to verify model fit. The model should be reviewed annually to verify that it still provides valid information.

SUMMARY AND RECOMMENDATIONS

This section details the composition of a four-layer, finite difference groundwater flow model. Software utilized for modeling is Visual MODFLOW Pro 3.0. Overall, calculated head values at observation points match observed trends. The model water mass balance sufficiently matches the water budget presented in the conceptual model in Section 2. Also, calculated groundwater flow directions match those presented in Section 2.

Data and numerical limitations enact restrictions on the evaluation of model. Data are spatially sparse which limits the extent of the model calibration. Numerically, the use of pumping wells for calibration purposes complicates calibration evaluation because of error induced by numerical limitations and potential errors during the collection of the pumping data (i.e. well was not completely recovered). In Visual MODFLOW, the extracted volume of groundwater is virtually spread over the entire horizontal computational cell, thereby damping the numerical response of the model to changes in pumping rates in that cell. Even with these complications, the groundwater model is useful as a groundwater resource planning tool. The model is able to quantitatively evaluate aquifer responses to induced stresses and proposed groundwater use scenarios. However, caution should be exercised is using the groundwater model to evaluate site-specific or absolute water levels. Rather, it provides a measure of relative performance of various groundwater management options.

Section 4
Baseline Conditions

The review of historical water conditions in Section 2 indicates that the Elsinore Basin in a state of groundwater deficit today. However, to determine whether these problems will continue, a reasonable estimate of future water conditions is necessary. These conditions include future water demands and the supplies required to meet those demands. They also provide a baseline for developing and comparing the effectiveness of the alternative management plans that are developed in **Section 5**. This section presents a discussion of future supplies and demands anticipated for the Elsinore Basin, the projected water balance and the expected impacts if no management plan is implemented. The section concludes with a discussion of the need for a management plan.

INTRODUCTION

As discussed in Section 1, potable water demands are projected to more than double by 2020. **Table 4-1** presents an accounting of the supplies and demands for the Elsinore Basin for existing conditions. Year 2000 data are used throughout this report to reflect current conditions to remain consistent with the estimates provided in the Water Distribution System Master Plan (MWH, 2002). The data presented herein include groundwater pumping from EVMWD, EWD and private pumpers. Total pumping in the Elsinore Basin during 2000 was approximately 8,200 acre-ft. Total water demands were approximately 23,400 acre-ft.

Table 4-1
Potable Water Demands in the Elsinore Basin – Year 2000

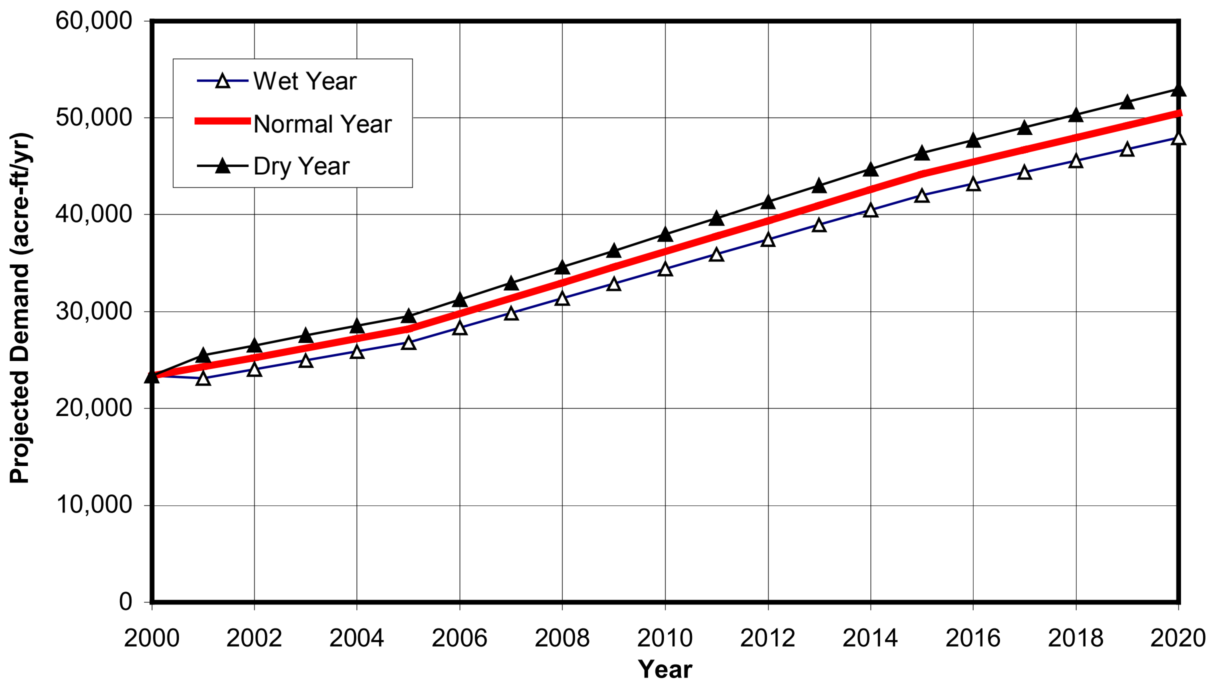
Description		Year 2000
Demand	Average Day Demand	23,400
Supplies	Existing Wells [1]	8,200
	Canyon Lake WTP	2,300
	Imported water from MWDSC (Auld Valley)	12,900
	Imported water from MWDSC (Temescal Valley)	0
	Total	23,400
Supply Shortfall		0

1 – Includes EVMWD, EWD and private wells.

Figure 4-1 presents a summary of the projected water demands for the Elsinore Basin through 2020. These projections are based upon the monthly potable demand projections presented in the Distribution System Master Plan (MWH, 2002). The potable demand projections are based upon SCAG population projections through 2025 and the amount of projected development through

2080 as described in the Distribution System Master Plan (MWH, 2002). Based upon discussions with EWD, it is assumed that EWD's demand will remain fixed in the future because its service area is essentially built-out. In addition, the demand for private pumpers is projected to remain constant as new developments will likely be supplied by EVMWD. This figure shows a range in demand assuming the average annual demand increases approximately 5 percent in dry years and decreases approximately 5 percent in wet years. As such, the potable demand is projected to range from 48,000 acre-ft/yr to 53,100 acre-ft/yr by 2020.

Figure 4-1
Summary of Projected Potable Water Demands through 2020



These projections do not include water demands for non-potable supplies such as recycled water or groundwater not suitable for potable use. As discussed in Section 1, recycled water is currently being used in to replenish Lake Elsinore on a pilot basis. Because the feasibility of a basin-wide recycled water system has not been determined at this time, additional studies may be necessary. Based upon a review of the local hydrology, for purposes of this report, wet years occur about 3 out of 10 years, dry years every 2 out of 10 and 5 out of 10 are considered normal years.

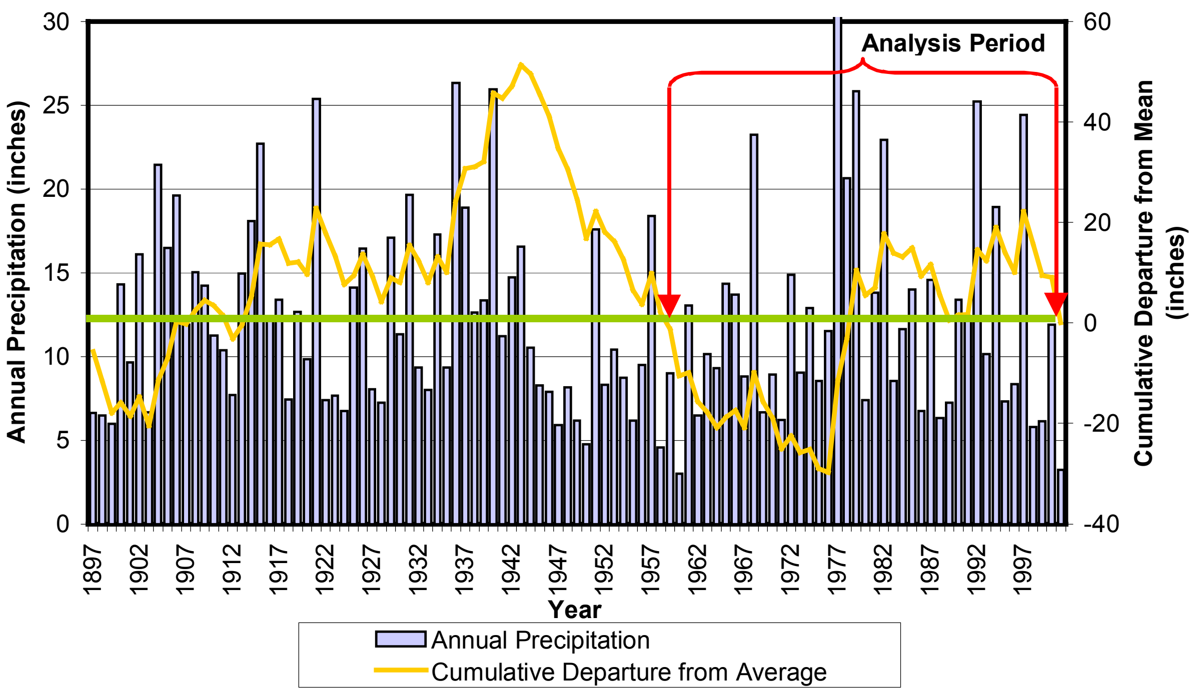
The remainder of this section discusses the future baseline conditions in the basin.

BASELINE CONDITIONS

Projections of future conditions are by their nature approximations and, as such, are frequently based on historical trends or on estimates made by others. In the development of future water demands and supplies, a number of assumptions have been made, as described below. The planning period for the GWMP is the year 2020. However, because the water balance analysis presented in Section 2 for the historical period 1990 to 2000 suggests that inflows to the basin are currently less than the outflows, it is important to evaluate the groundwater impacts of this situation continuing in the future. Therefore, two future baseline conditions have been developed for this GWMP.

Baseline A simulates current (year 2000) groundwater pumping patterns in the basin. Baseline B simulates expected pumping conditions in the basin in year 2020 without the implementation of any groundwater management activities. To evaluate the potential range in groundwater conditions in the basin, the hydrologic conditions for the period October 1960 through September 2001 are used. This 41-year period represents a period of precipitation that closely approximates the long-term average rainfall and includes a wide range of wet, normal and dry years as shown in **Figure 4-2**. The baseline conditions and the groundwater levels predicted with the groundwater model are described below.

Figure 4-2
Annual Precipitation at Lake Elsinore



This approach of modeling the basin is used to evaluate the baseline conditions and the alternatives because it provides the ability to define the potential range of conditions based upon hydrology given a fixed set of groundwater pumping conditions.

Baseline A – Current Basin Conditions

Baseline A is based on year 2000 conditions for water demands, operating groundwater wells, and the degree of urbanization of the basin area. The purpose of Baseline A is to compare the current pumping conditions with the basin conditions in year 2020 due to increased water demands, increased urbanization (reduced infiltration) and increased groundwater production from additional planned groundwater wells.

Planning Assumptions

The following is a description of the planning assumptions for Baseline A. According to MWDSC, their imported water supply is sufficient to meet projected demands for the next 20 years (MWDSC, 2003). Therefore, supply projections are made assuming that the TVP and the AVP can be used to full capacity when necessary.

Water Demands

The water demands used in Baseline A are the combined year 2000 demands of EVMWD, EWD, and the private pumpers. As discussed above, the demand in 2000 was 23,400 acre-ft. If these demands are projected into the future, taking into consideration wet and dry year cycles, current demands would range from 22,300 acre-ft/yr in wet years to 24,600 acre-ft/yr in dry years as shown in **Table 4-2**.

Table 4-2
Potable Water Demands in the Elsinore Basin – Baseline A

Description		Actual 2000 (acre-ft/yr)	Normal Year 2000 (acre-ft/yr)	Dry Year 2000 (acre-ft/yr)	Wet Year 2000 (acre-ft/yr)
Demand	Average Annual Demand	23,400	23,400	24,600	22,300
Supplies	Existing Wells	8,200	9,900	9,900	9,900
	Canyon Lake WTP	2,300	3,000	700	6,600
	MWDSC (AVP)	12,900	6,600	6,600	4,500
	MWDSC (TVP)	0	3,900	7,400	1,300
	Total	23,400	23,400	24,600	22,300
Supply Deficit		0	0	0	0

Water Supplies

To meet the potable demand, the water supplies included in Baseline A are:

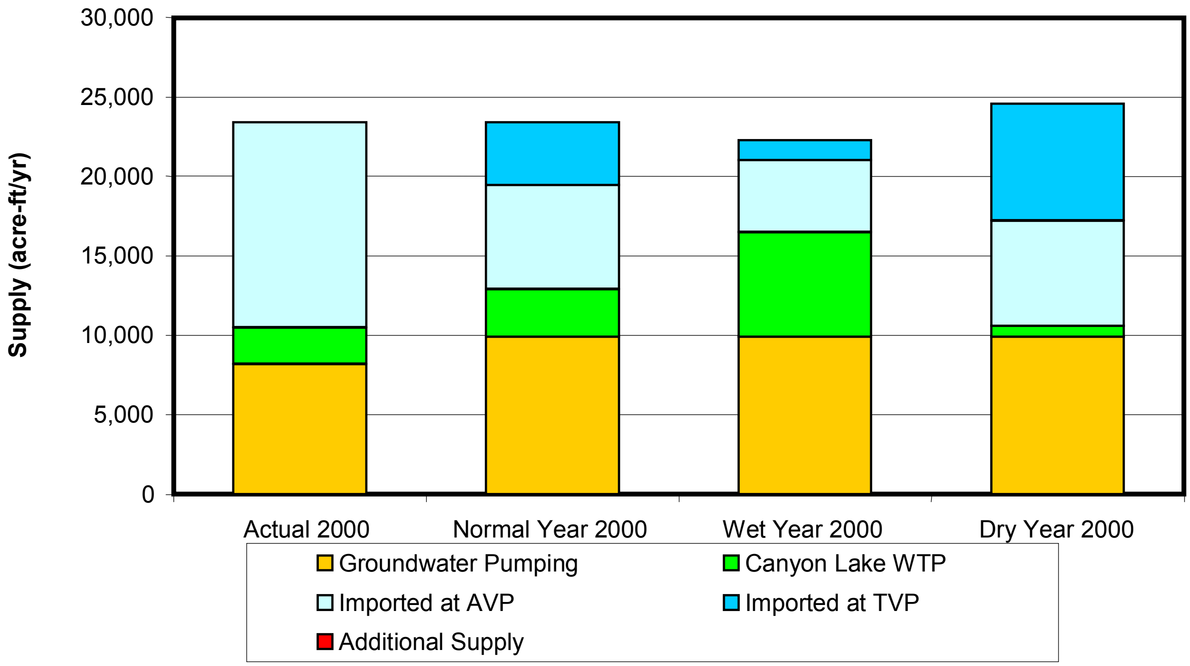
- Eight existing groundwater wells of EVMWD with a total capacity of 11,600 gallons per minute (gpm).
- Four existing groundwater wells of EWD with a total capacity of 3,400 gpm.
- Unknown number and capacity of private wells.
- Imported water from AVP with a capacity of 14,000 gpm (22,600 acre-ft/yr).
- Imported water from TVP with a capacity of 15,300 gpm (24,700 acre-ft/yr).

- Canyon Lake WTP with a capacity of 6,250 gpm with annual flows ranging from 700 to 6,600 acre-ft/yr when operating.

Groundwater production estimates are made based upon actual production data from 1997 to 2001 and reflect the average production from each well in the basin over this 5-year period and includes the new EVMWD Machado Street well because it was on-line during 2001. Therefore, the estimated production for Baseline A conditions (9,900 acre-ft/yr) is slightly higher than the actual conditions in 2000. In addition, the groundwater pumping is kept constant during wet and dry years to evaluate the affects of varying hydrology on the groundwater basin only. The proposed EVMWD Joy Street and Terra Cotta wells are not included in Baseline A because these wells were not online in 2000 or 2001.

Similarly, imported water from the TVP was not available to EVMWD in 2000. Projections for Baseline A include the use of imported water from the TVP. Neither the TVP nor the AVP reach capacity under Baseline A. A summary of the projected supplies to meet the demands is provided in **Figure 4-3**. No additional supplies are required to meet current demands under this scenario. However, the ability of the groundwater basin to sustain this level of pumping through a wide range of hydrologic conditions must be evaluated.

Figure 4-3
Summary of Supplies to Meet Projected Demands – Baseline A



Note: The amount of groundwater pumping presented in this figure does not allow sustainable basin conditions.

Land Use

In Baseline A, the land use for year 2000 is used to calculate the amount of infiltration from precipitation in the local watershed and the amount of return flows from irrigation.

Septic Tanks

It is estimated that approximately 3,900 septic tanks are located within the groundwater basin. These septic tanks contribute to about 1,000 acre-ft of infiltration per year. Baseline A assumes that none of these septic tanks will be connected to the sewer system.

Lake Replenishment

No lake replenishment using groundwater or reclaimed water is included in Baseline A because lake replenishment was not performed prior to 2002.

Groundwater Balance

The estimated groundwater balance based upon 1961 to 2001 hydrology for Baseline A is summarized in **Table 4-3**. Note that this groundwater balance reflects projected future conditions with historical inflows and is therefore, not directly related to the actual conditions presented in Section 2. If groundwater pumping conditions for 2000 continued for a repeat of the 41-year hydrologic analysis period, an average deficit of approximately 4,400 acre-ft/yr would occur. The annual basin balance is projected to range from a deficit of 8,200 acre-ft/yr in dry years similar to water year 1960-61 to a surplus of as much as 10,800 acre-ft/yr in wet years similar to water year 1980-81.

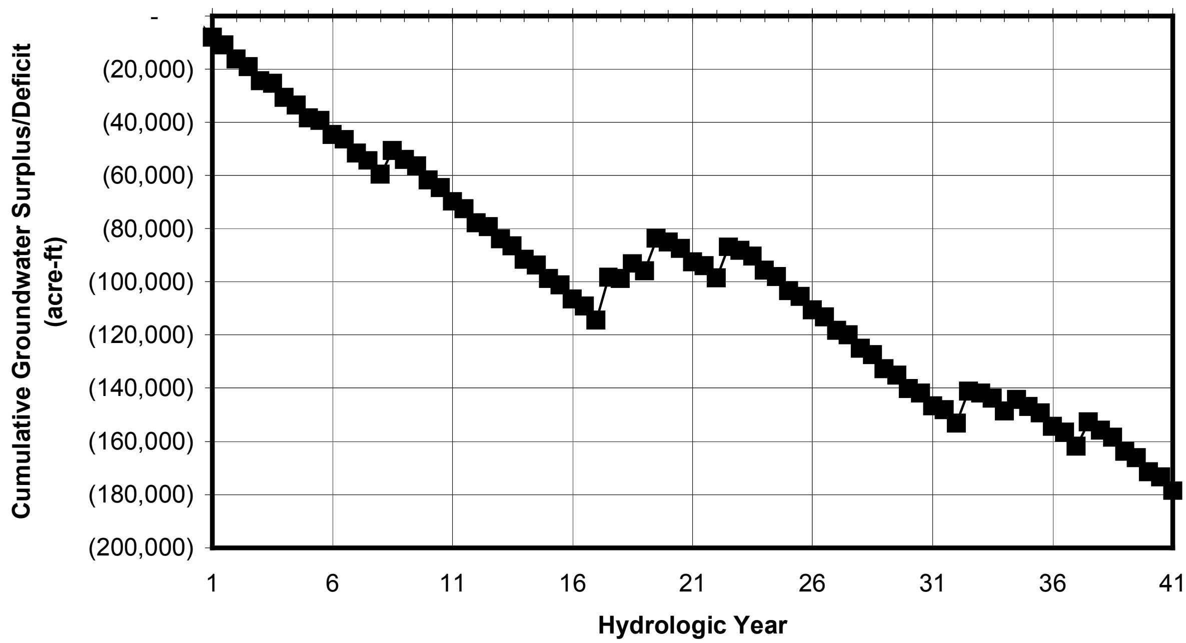
Table 4-3
Summary of Groundwater Balance – Baseline A

Parameter	Average (acre-ft/yr)	Wet Year (acre-ft/yr)	Dry Year (acre-ft/yr)
INFLOWS			
Infiltration of Precipitation			
Rural Areas	1,700	9,500	0
Urban Areas	900	5,500	0
Recharge from Surface Water			
San Jacinto River	1,200	4,000	0
Lake Elsinore	0	0	0
Return Flows			
Septic Systems	1,000	1,000	1,000
Applied Water	700	700	700
Subsurface Inflows		-	-
Total Inflows	**5,500**	**20,700**	**1,700**
OUTFLOWS			
Groundwater Pumpage	(9,900)	(9,900)	(9,900)
Surface Outflow	0	0	0
Subsurface Outflow	0	0	0
Total Outflows	**(9,900)**	**(9,900)**	**(9,900)**
Net Surplus/(Deficit)	**(4,400)**	**10,800**	**(8,200)**

Base period = 1961 to 2001

Figure 4-4 presents the projected cumulative groundwater balance for the Elsinore Basin under Baseline A for the 41-year simulation. As shown in this figure, the basin would lose approximately 176,000 acre-ft of storage (about 12 percent of the basin storage) after 41 years if pumping were kept constant at the Baseline A rate. Because the natural inflows and outflows are approximately equal during this period, a deficit would indicate that the basin is not currently in balance and the existing condition is not sustainable.

Figure 4-4
Projected Cumulative Groundwater Balance - Baseline A

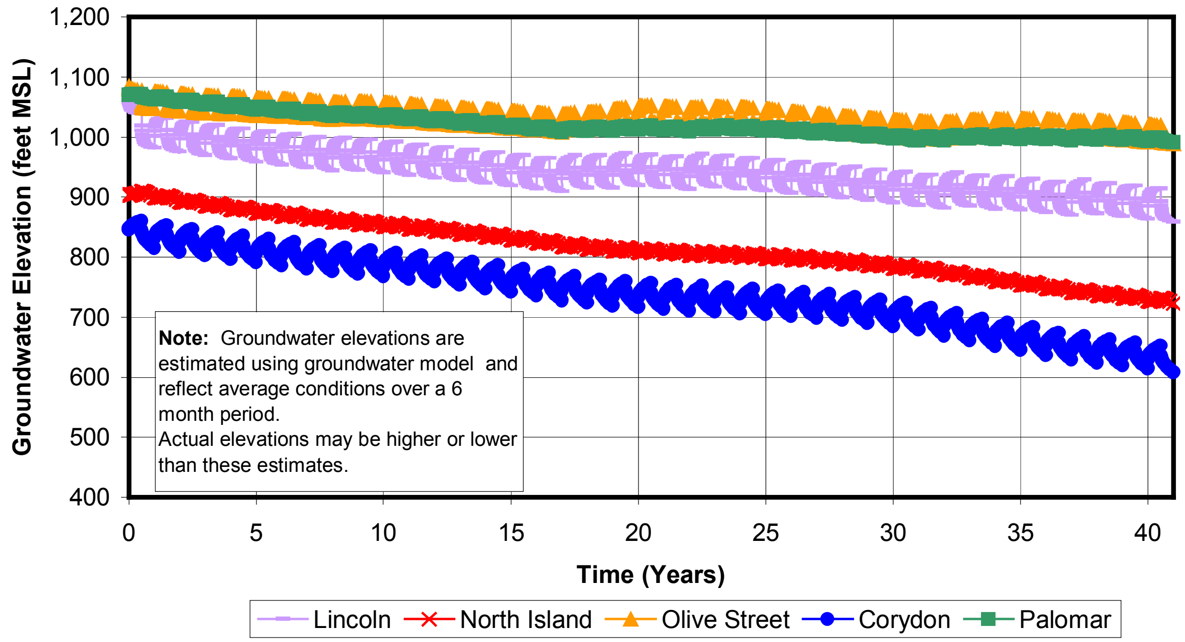


Water Levels

The predicted water levels in the Elsinore Basin for Baseline A conditions are presented in **Figure 4-5**. As shown in this figure, the water levels are declining throughout the groundwater basin. Water levels in the Corydon well, for example, are projected to decline as much as 250 feet over 41 years. Water levels in wells near the edge of the basin (e.g. Olive Street and Palomar) are projected to decline on the order of 80 to 90 feet. Other wells are projected to decline as much 200 feet. As discussed above, this condition is not sustainable. Impacts of this condition include:

- Water quality degradation as poor quality water migrates from other portions of the basin
- Increased risk of land subsidence that may result in damage to infrastructure
- Aquifer subsidence that may result in permanently reduced yield and storage capacities
- Reduced well pumping capacities due to shorter wetted screen intervals
- Mitigation costs to private users relying on this groundwater basin
- Reduced supply reliability in prolonged drought periods or emergencies such as earthquakes.
- Loss of habitat in wetlands and reduction of recreation industry if water for lake replenishment is not available.

Figure 4-5
Projected Water Levels of Baseline A – Existing Conditions



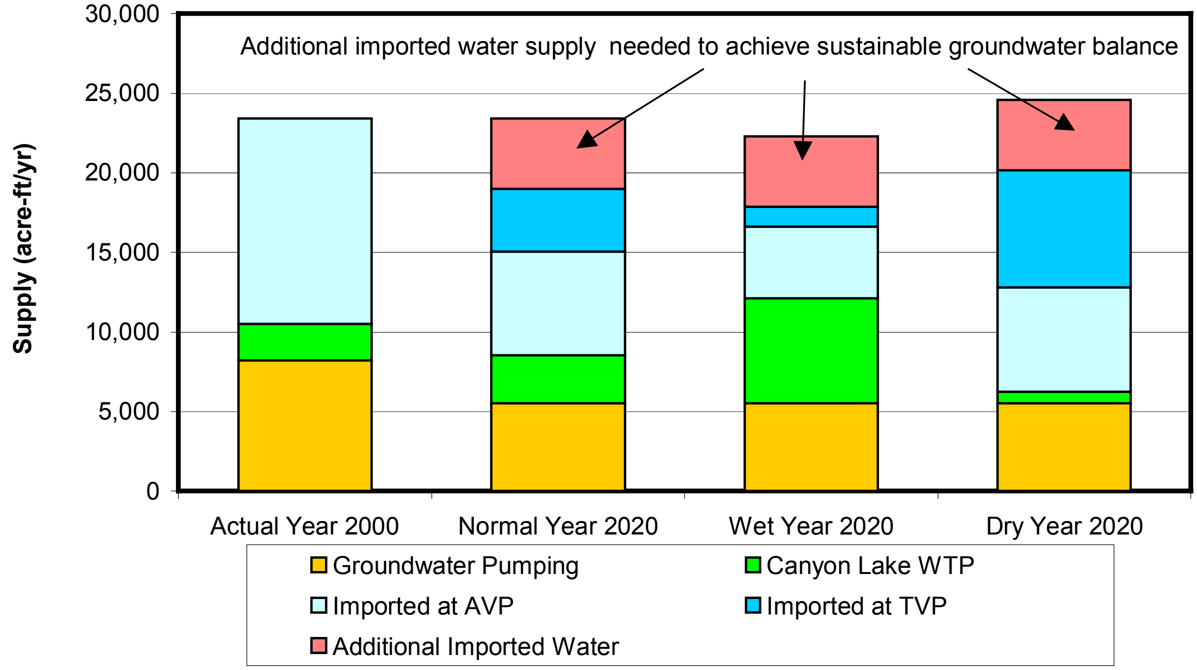
Under current pumping conditions, the average long-term groundwater deficit is about 4,400 acre-ft/yr. Therefore, without a groundwater management strategy, 9,900 acre-ft/yr could not be pumped from the basin over the long-term without significant detrimental impacts, which results in additional supply deficit. To obtain a sustainable balance in the basin, an additional 4,400 acre-ft/yr of imported water supplies would need to be purchased to reduce groundwater pumping to the current sustainable yield (5,500 acre-ft/yr) as shown in **Figure 4-6**. The supply picture presented here is significantly different from the data presented in Figure 4-3 and may not be feasible for future demands. Therefore, Baseline B addresses future conditions in the Elsinore Basin.

Baseline B – Year 2020 Basin Conditions

Baseline B is based on the anticipated future conditions in year 2020 with respect to water demands, operating groundwater wells, and the degree of urbanization of the basin area. Baseline B has a dual purpose:

- Baseline B is used to compare the basin conditions in year 2020 with the current (year 2000) basin conditions to quantify the effects of increased pumping and decreased infiltration due to projected development.
- Baseline B provides a basis for evaluation of management alternatives, which represent the year 2020 conditions as well.

Figure 4-6
Supply Mix to Meet the Projected Year 2020 Demands with Sustainable Groundwater Balance– Baseline A



Planning Assumptions

The following discusses the planning assumptions for Baseline B.

Water Demands

The water demands of EVMWD are projected to increase to 50,000 acre-ft in year 2020 (MWH, May 2002), while the water demands of EWD and private pumpers are assumed to remain constant at 500 acre-ft/yr. Under normal hydrologic conditions, the total demand is 50,500 acre-ft/yr. In a dry year, the demand is assumed to increase by five percent to 53,100 acre-ft/yr. In a wet year, the demand is assumed to decrease by five percent to 48,000 acre-ft/yr. A summary of the potable demands and supplies is presented in **Table 4-4**.

Water Supplies to Meet Demands

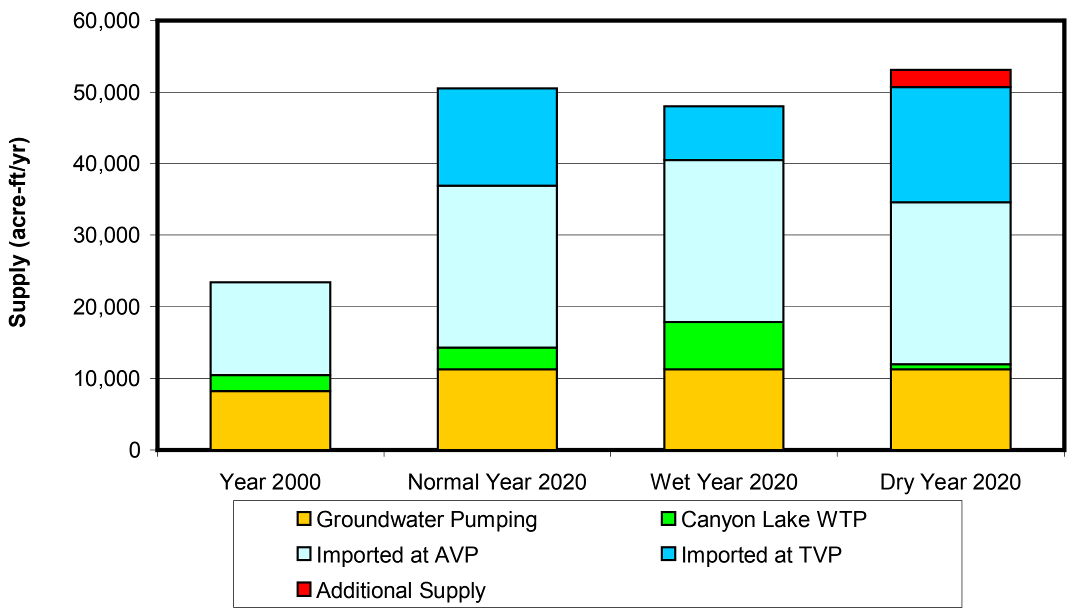
The water supplies included in Baseline B are the same as Baseline A plus the Joy Street Well, which is drilled, and ready to be equipped. The Joy Street Well has an estimated capacity of 1,000 gpm, which increases the groundwater production to 11,300 acre-ft/yr. To meet the maximum day demands (MDD) in year 2020, 14 additional wells are required to provide peaking capacity, assuming that each well has a capacity of 1,000 gpm, or another peaking source is needed. According to MWDSC, their imported water supply is sufficient to meet projected demands for the next 20 years (MWDSC, 2003). Therefore, supply projections are made assuming that the TVP and the AVP can be used at capacity if necessary. The groundwater supplies accounted for here include only those supplies used to meet potable demands. The use of recycled water and non-potable groundwater supplies for lake replenishment is discussed later.

Table 4-4
Potable Water Demands in the Elsinore Basin – Baseline B

Description		Year 2000 (acre-ft/yr)	Normal Year 2020 (acre-ft/yr)	Dry Year 2020 (acre-ft/yr)	Wet Year 2020 (acre-f/yr)
Demand	Average Annual Demand	23,400	50,500	53,100	48,000
Supplies	Existing Wells	8,200	11,300	11,300	11,300
Supplies	Canyon Lake WTP	2,300	3,000	700	6,600
	MWDSC (AVP)	12,900	22,600	22,600	21,600
	MWDSC (TVP)	0	13,600	16,100	8,500
	Total	23,400	50,500	50,700	48,000
Supply Shortfall		0	0	2,400	0

Figure 4-7 presents a graph of the projected supplies and demands under Baseline B. This figure implies that there are sufficient supplies in existing facilities to meet the potable demand in normal and wet years, while only dry years have a supply shortfall of approximately 2,400 acre-ft/yr. However, Baseline B results in groundwater pumping in excess of the perrenial yield. Therefore, a supply deficit actually occurs in all years.

Figure 4-7
Supply Mix to Meet the Projected Year 2020 Demands – Baseline B



Note: The amount of groundwater pumping presented in this figure does not allow sustainable basin conditions.

Land Use

In Baseline B, the projected land use from the General Plans of the City of Lake Elsinore (City of Lake Elsinore, 1990) and Riverside County (Riverside County, 1994) for year 2020 is used to calculate the amount of runoff and the amount of return flows from irrigation.

Septic Tanks

The amount of infiltration from septic tanks in Baseline B is approximately 1,000 acre-ft per year, which is the same as in Baseline A. This is based on the assumption that septic tanks installed for new developments in the basin, will offset the number of existing septic tanks that are connected to the EVMWD sewer system by year 2020.

Lake Replenishment

Lake Elsinore replenishment is assumed to be accomplished with a combination of recycled water and groundwater when the lake level drops below elevation 1,240 feet MSL. Recycled water from the Regional WWTP would be used as the primary source of replenishment water up to 7.5 mgd (the current capacity of the plant less 0.5 mgd to Temescal Wash). The three Island wells would be used as the secondary source when the reclaimed water supply is not adequate to maintain the lake level at elevation 1,240 MSL. A summary of the lake replenishment requirements for Lake Elsinore is provided in **Figure 4-8** and in **Table 4-5**.

Figure 4-8
Summary of Lake Replenishment Requirements for Baseline B

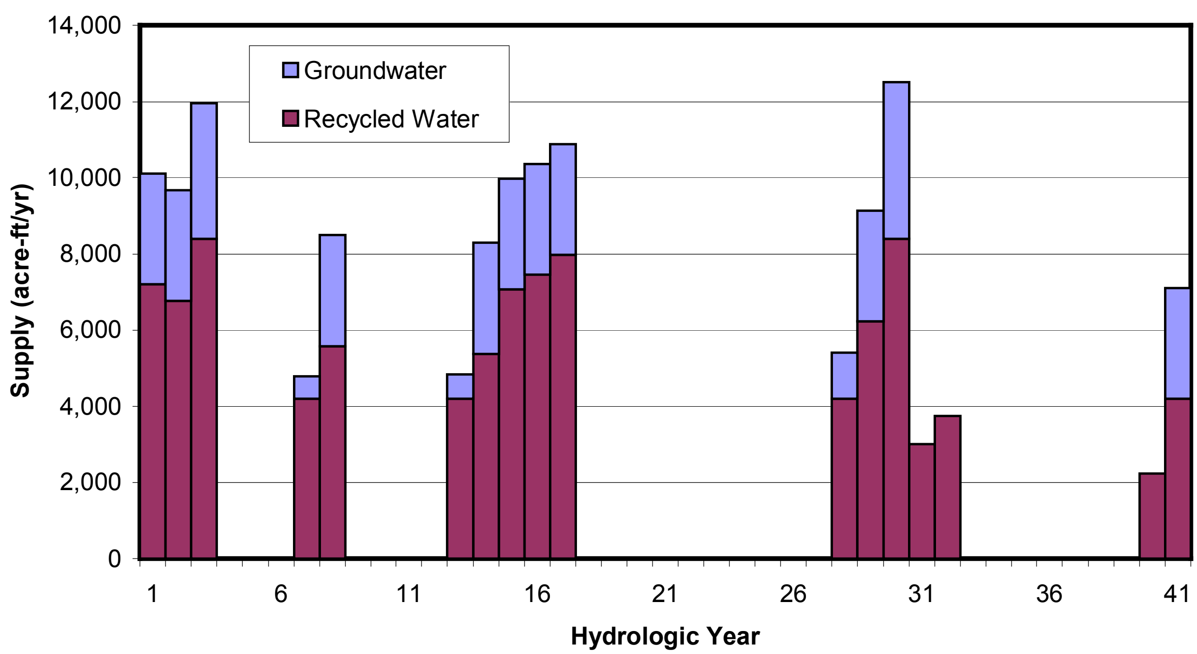


Table 4-5
Range of Lake Replenishment Requirements – Baseline B

Parameter	Year 2000 (acre-ft/yr)	Normal Year 2020 (acre-ft/yr)	Wet Year 2020 (acre-ft/yr)	Dry Year 2020 (acre-ft/yr)
Recycled Water from Regional WWTP				
Capacity (8 mgd)	9,000	9,000	9,000	9,000
Used for Lake Makeup	0	2,300	0	8,400
Groundwater	0	900 [1]	0 [2]	4,100 [3]
Total Used for Lake Makeup	0	3,200	0	12,500

1 – Normal year based upon average over 41 years
2 – Wet year based upon hydrologic year 1981
3 – Dry year based upon hydrologic year 1990, which had the highest lake demand.

As shown in Table 4-5, an average of about 3,200 acre-ft/yr is necessary to maintain Lake Elsinore at an elevation of 1240 feet MSL. As shown in Figure 4-8, lake makeup water is needed about 40 percent of the time. When required, about 70 percent of the makeup water is projected to come from recycled water from the Regional WWTP. No lake makeup water is necessary during wet years as local runoff is sufficient to maintain the lake level. Up to 12,500 acre-ft/yr of lake makeup would be required if conditions during water year 1990 were repeated. Because the highest lake demand (water year 1990) presented in Table 4-5 is not coincident with the driest single year in the Elsinore Basin (water year 1961) presented in Table 4-6, the groundwater pumping in these tables differs.

Groundwater Balance

A summary of the groundwater balance under Baseline B is provided in **Table 4-6**. If groundwater conditions of Baseline B continued for the next 41 years, an average deficit of approximately 6,500 acre-ft/yr would occur. The annual basin balance is projected to range from a deficit of more than 12,100 acre-ft/yr in dry years similar to 1960-1 (which was the driest single year over the 41-year simulation) to a surplus of as much as 8,300 acre-ft/yr in wet years similar to 1980-1.

Figure 4-9 presents the projected cumulative groundwater balance for the Elsinore Basin under Baseline B for the 41-year simulation. As shown in this figure, the basin is projected to lose approximately 264,000 acre-ft of storage after 41 years (nearly 20 percent of the basin storage). Because inflows during this period are approximately equal to the long-term average for the basin, a deficit would indicate that the basin is not currently in balance and the projected 2020 conditions are not sustainable.

Table 4-6
Summary of Groundwater Balance – Baseline B

Parameter	Average (acre-ft/yr)	Wet Year [1] (acre-ft/yr)	Dry Year [1] (acre-ft/yr)
INFLOWS			
Infiltration of Precipitation			
Rural Areas	1,700	9,500	0
Urban Areas	700	4,000	0
Recharge from Surface Water			
San Jacinto River	1,200	4,000	0
Lake Elsinore	0	0	0
Return Flows			
Septic Systems	1,000	1,000	1,000
Applied Water	1,100	1,100	1,100
Subsurface Inflows	0	0	0-
Total Inflows	**5,700**	**19,600**	**2,100**
OUTFLOWS			
Groundwater Pumpage	(11,300)	(11,300)	(11,300)
Pumping for Lake Replenishment	(900)	0 [1]	(2,900) [2]
Subsurface Outflow	0	0	0
Total Outflows	**(12,200)**	**(11,300)**	**(14,200)**
Net Surplus/(Deficit)	**(6,500)**	**8,300**	**(12,100)**

1 – Wet year is based upon hydrologic year 1981
2 – Dry year based upon hydrologic year 1961. This year differs from hydrologic period shown in Table 4-5. Therefore, data presented are different. See text for further discussion.

Water Levels

The predicted water levels in the Elsinore Basin for the conditions of Baseline B are presented in **Figure 4-10**. As shown in this figure, the water levels are declining throughout the basin. The decrease in water levels under Baseline B conditions is also greater than the decrease in water levels under Baseline A conditions. For example, water levels in the Corydon Street well are projected to drop more than 400 feet over the simulation period. Water levels in the north end of the lake near Lincoln Street well are projected to drop more than 200 feet. Declining water levels can lead to other detrimental effects such as land subsidence, increased pumping costs, loss of production capacity and water quality degradation.

As discussed above, the projected average long-term deficit in the basin is approximately 6,500 acre-ft/yr, assuming that the groundwater pumping continues at the current rate as well as the planned addition of Joy Street Well. The future sustainable yield of the basin is projected to be about 5,700 acre-ft/yr (slightly higher than under current conditions because of increased applied water returns). To maintain a sustainable yield, the groundwater pumping needs to be reduced

Figure 4-9
Projected Cumulative Groundwater Balance - Baselines A and B

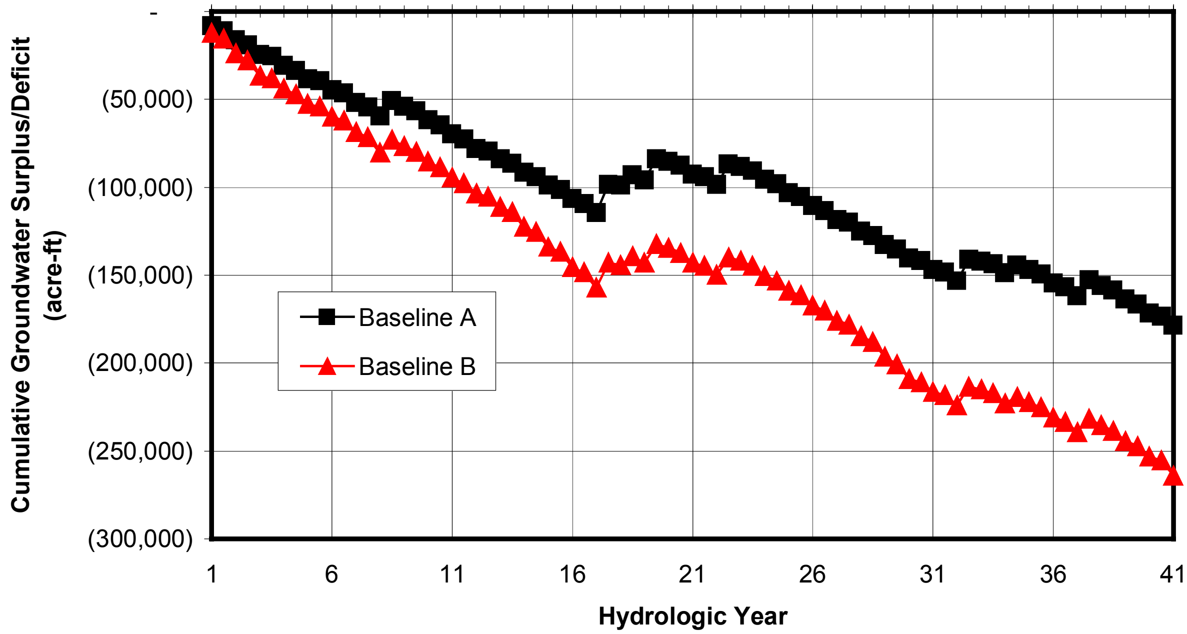
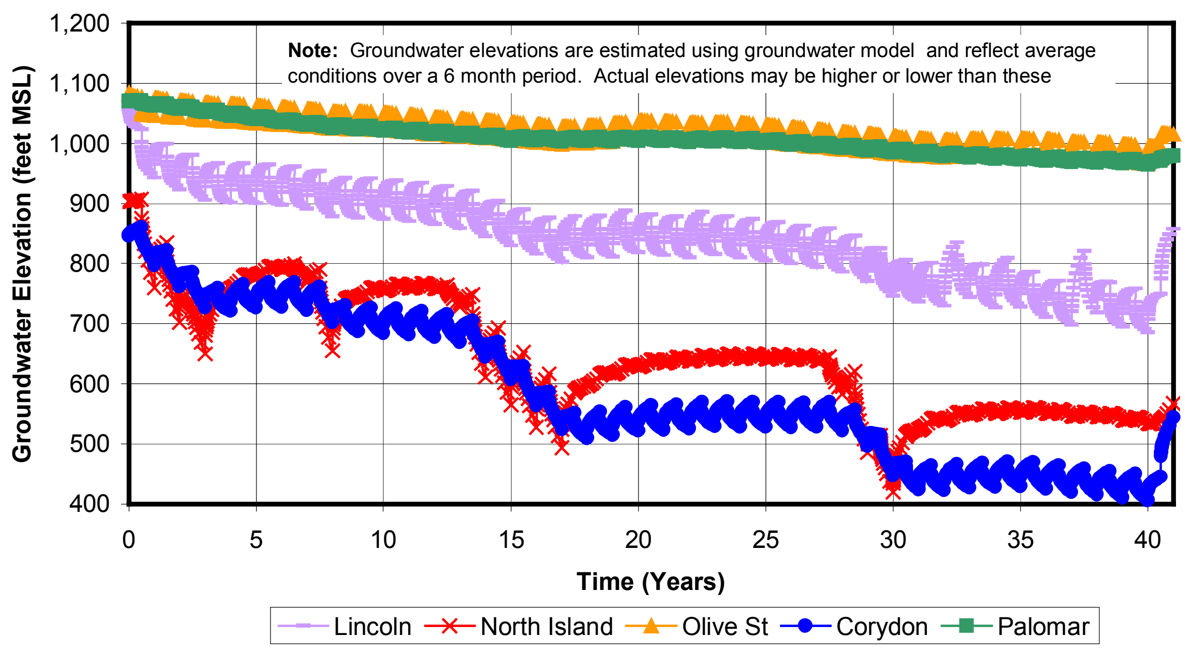


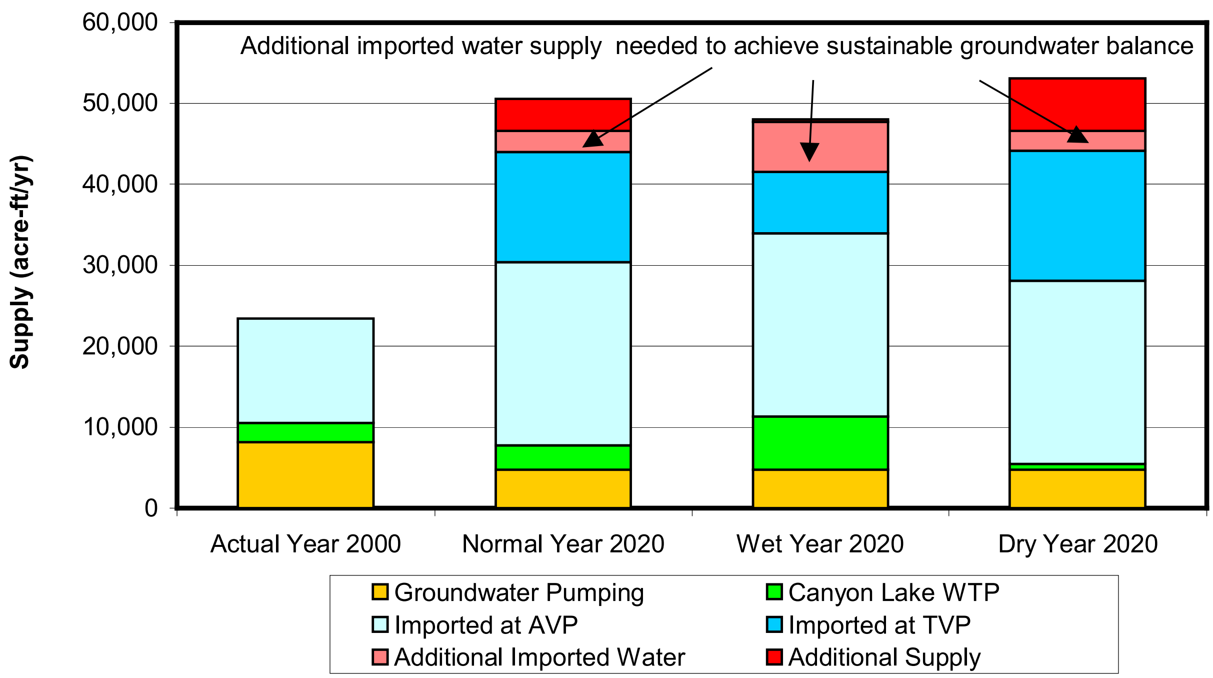
Figure 4-10
Projected Water Levels of Baseline B – Future Conditions



by 6,500 acre-ft/yr, which would needs to be replaced with additional imported water or other water supply.

This situation is presented graphically in **Figure 4-11**. This figure shows that to maintain a sustainable balance, additional supplies will be needed in the summer months in all years to maintain a sustainable yield assuming that groundwater pumping is reduced evenly throughout the year by 42 percent. This figure shows that from 300 acre-ft/yr to 6,500 acre-ft/yr of new supply (shown in red) would be required to meet the projected year 2020 demands.

Figure 4-11
Supply Mix to Meet Year 2020 Demands
with Sustainable Groundwater Balance– Baseline B



NEED FOR MANAGEMENT PLAN

As illustrated with the water balance in Section 2 and the projected water levels of Baseline A, the conditions of the Elsinore Basin indicate that the groundwater basin may be in a state of overdraft. A continuation of the current conditions to year 2020 will result in an increased overdraft as illustrated with the decreasing water levels in Baseline B. Water quality degradation and increased risk of land subsidence are two of the related adverse impacts of these declining water levels. Estimates of total volume of water in storage range from 1.45 million acre-ft (Fox, 1999) to 1.8 million acre-ft (DWR, 1981). Without the project in 2020 (Baseline B), the basin would lose nearly 20 percent of its storage on a long-term basis. The impacts of this lost storage include:

- Water quality degradation as poor quality water migrates downward throughout the basin
- Increased risk of land subsidence that may result in damage of infrastructure
- Aquifer subsidence that may result in permanent reduced yield and storage capacities
- Reduced well pumping capacities due to shorter wetted screen intervals

- Increased cost of potable water for EVMWD's customers
- Reduced supply reliability in prolonged drought periods or emergencies such as earthquakes.
- Loss of habitat in wetlands and reduction of recreation industry if water for lake replenishment is not available.

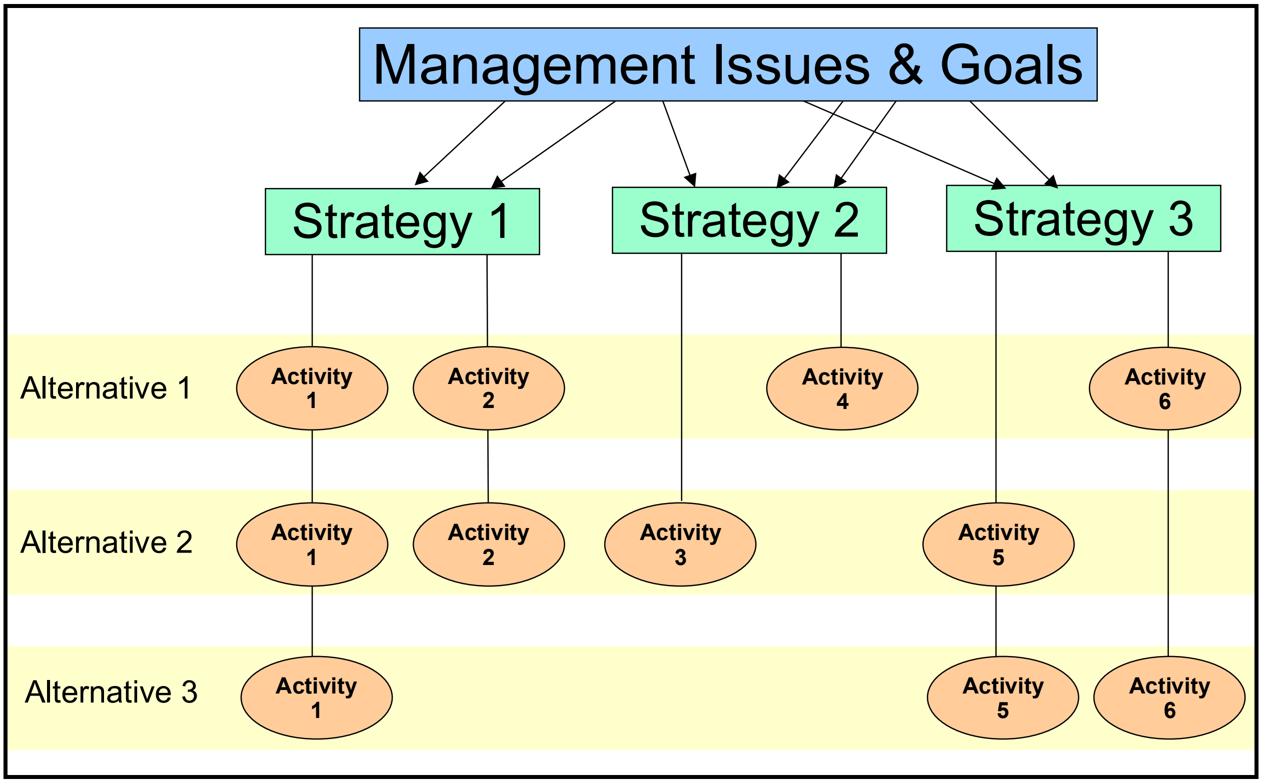
As a result, it is imperative that the District develop a GWMP that will resolve the overdraft problem and protect the groundwater supply for use by future generations. To develop a comprehensive groundwater management plan that incorporates all the management issues of the Elsinore Basin, a complete inventory of management issues is needed. The inventory of management issues is discussed in the following section.

Section 5
Management Issues and Strategies

INTRODUCTION

This section describes the development of groundwater management alternatives that will be evaluated in the GWMP. To define the management alternatives, a three-step process is followed as presented in **Figure 5-1**.

Figure 5-1
Process to Define Management Alternatives



First, an inventory of the groundwater basin management issues is prepared, which are then translated into management goals. To address these management issues, various general management strategies are defined (e.g. surface spreading or water conservation). For each management strategy, one or more specific activities are defined that can be implemented in the Elsinore Basin. For example, for the strategy "Surface Spreading", activities may include spreading basins in Leach Canyon or McVicker Canyon. Finally, a total of four management alternatives are defined by creating unique combinations of multiple activities. The description of these alternatives is presented in Section 6.

GROUNDWATER MANAGEMENT ISSUES

The Groundwater Management Act (California Water Code, Part 2.75, §10753), also known as AB3030 and amended by SB1938, provides the authority to prepare groundwater management plans. Section 10753.7 identifies twelve specific components or issues that may be included in a groundwater management plan. Groundwater management plans developed with these components permit local agencies to adopt programs to manage groundwater and serve as guidelines for this groundwater management plan.

An AB3030 groundwater management plan may include the following:

- Control of saline water intrusion
- Identification and management of wellhead protection areas and recharge areas
- Regulation of the migration of contaminated groundwater
- Identification of well construction policies
- Administration of a well abandonment and well destruction program
- Construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling and extraction projects
- Review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination
- Mitigation of conditions of overdraft
- Replenishment of groundwater extracted by water producers
- Monitoring of groundwater levels and storage
- Facilitating conjunctive use operations
- Development of relationships with state and federal regulatory agencies

In addition to the twelve components defined under AB3030, the conditions of the Elsinore Basin and EVMWD's water supply are evaluated to identify other specific management issues for both existing and anticipated future conditions. Additional management issues related to the existing basin conditions include:

- Meeting current and future drinking water quality regulations for EVMWD's potable wells
- The increased dependence on imported water supplies due to the doubling of water demands in the next 20 years
- The increased use of groundwater for groundwater and Lake replenishment requirements
- The potential impact of groundwater management activities on hot spring wells
- Risk of liquefaction and subsidence

A detailed description and the assessment of the issues listed in the AB3030 requirements, and the existing and future potential issues (17 in total) are given below. A summary table is also provided in **Appendix F**.

AB3030 Issues and Components

The following section describes the issues and components identified under §10753.7 of the Water Code that may be included in a groundwater management plan. The format for this discussion follows the potential management issues described in **Table 5-1**.

1. Saline Water Intrusion

One of the components identified by AB3030 is the control of saline water intrusion. Saline water intrusion includes the following:

- Increase in salt content dissolved from earth materials
- Lateral or upward migration of saline water
- Downward seepage of sewage, agricultural, or industrial waste
- Downward seepage of mineralized surface water
- Interzonal or interaquifer migration of saline water
- Sea water intrusion

Although Lake Elsinore water has a higher salt concentration than the underlying groundwater, the lake is not considered as a potential source of downward seepage of saline water because the lake bottom sediments and underlying clay layers prevent migration of the lake water into the groundwater system. Three wells (known as the Island wells) were installed in the 1960s in the southern region of the lake to pump groundwater to the lake to maintain the water levels in the lake during times of low natural inflow. The Middle Island well has a leak in the well casing, which may have allowed higher TDS water to migrate from the alluvium into the underlying Fernando Group. EVMWD is currently repairing this well to prevent future contamination.

The Elsinore Basin is located more than 50 miles from the ocean. Therefore, seawater intrusion is not considered a threat. Based upon recent groundwater quality data, the remainder of the basin is not characterized by saline water and therefore, saline water intrusion is not a significant issue for the Elsinore Basin. Other water quality issues are discussed below.

2. Wellhead Protection

The identification and management of wellhead protection areas and recharge areas is another component that is recommended to be evaluated under the AB3030 requirements. On behalf of EVMWD, Kennedy/Jenks Consultants prepared a Drinking Water Source Assessment and Protection Plan in March 2002. The plan included an evaluation of EVMWD's eight groundwater wells and possible contamination activities located within 2-, 5-, and 10-year fixed radii from these wells. For example, a 10-year radius is the distance from a well that groundwater travels in a 10-year period.

Table 5-1
List of Potential Management Issues

Issue Number	AB3030 & SB1938	Description	Applicability to Elsinore Basin
AB3030/SB1938 Issues			
1	Yes	Control of saline water intrusion	Not Significant
2	Yes	Identification and management of wellhead protection areas and recharge areas	Existing
3	Yes	Regulation of the migration of contaminated groundwater	Existing
4	Yes	Identification of well construction policies	Existing
5	Yes	The administration of a well abandonment and well destruction program	Existing
6	Yes	Construction and operation by the local agency of groundwater contamination cleanup, recharge, storage, conservation, water recycling and extraction projects	Existing
7	Yes	Review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination	Existing
8	Yes	Mitigation of conditions of overdraft (water balance, water levels, and land subsidence)	Existing
9	Yes	Replenishment of groundwater extracted by water producers	Existing
10	Yes	Monitoring of groundwater production, levels, storage and water quality	Existing

Table 5-1 (continued)
List of Potential Management Issues

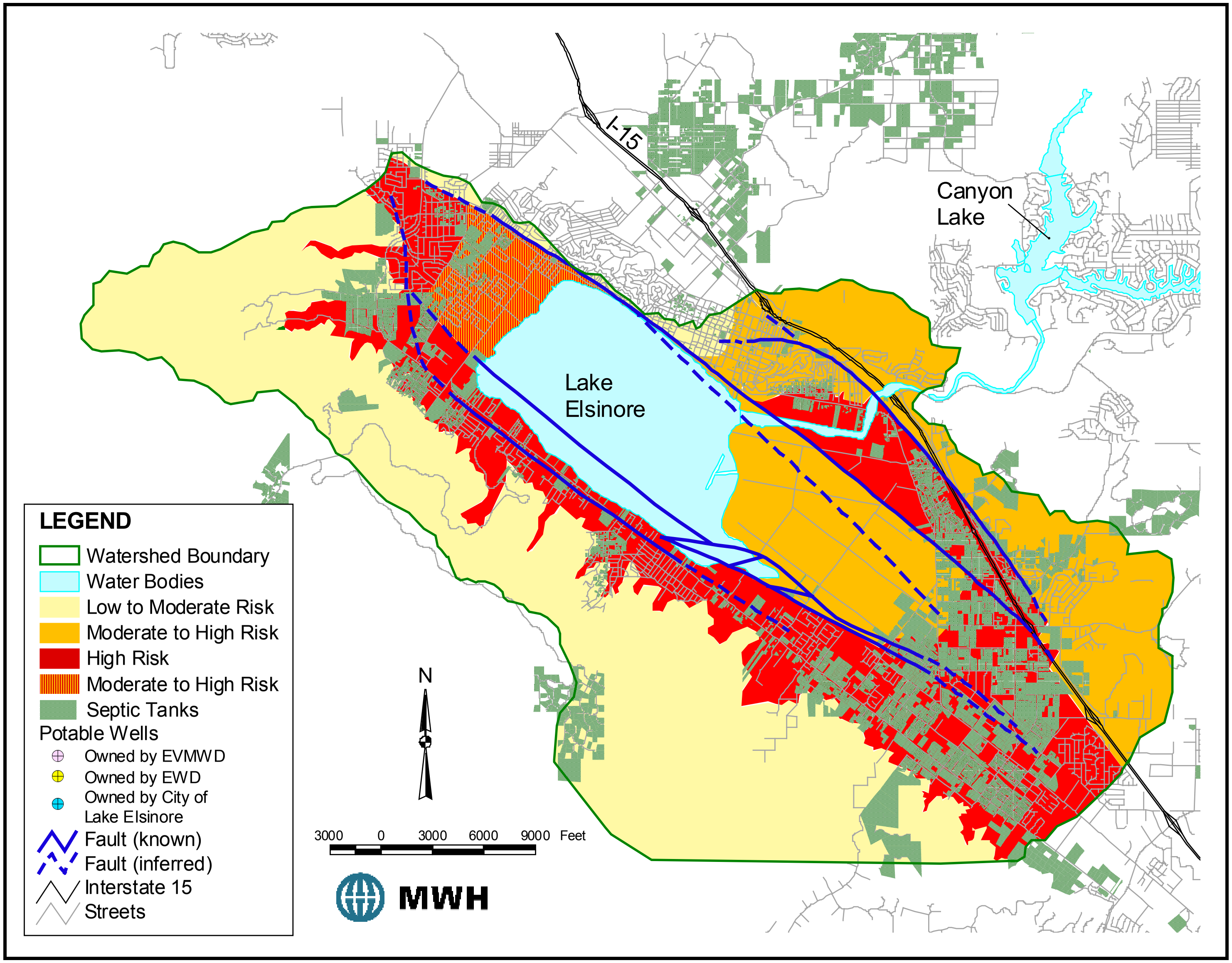
Issue Number	AB3030 & SB1938	Description	Applicability to Elsinore Basin
11	Yes	Facilitating conjunctive use operations	Existing
12	Yes	Development of relationships with state and federal regulatory agencies	Existing
Other Management Issues			
1	No	Compliance with drinking water quality regulations and Basin Plan Objectives	Existing
2	No	The increased dependence on imported water supplies due to the doubling of water demands in the next 20 years	Existing
3	No	The increased need for groundwater due to lake replenishment requirements	Existing
4	No	The potential impact of groundwater management activities on hotspring wells	Not Significant
5	No	Risk of liquefaction	Future

3. Migration of Contaminated Groundwater

The downward seepage of sewage, agricultural, or industrial waste is a potential source of groundwater contamination. The EVMWD service area includes residential and industrial land uses. Agricultural land use has greatly diminished in the last ten years and is currently limited to residential parcels. However, in some areas (e.g. the north end of the lake) where historical agricultural land use was present, there is a potential for downward migration of high TDS and sulfate groundwater. In areas with close proximity to septic tanks, downward migration of nitrate occurs

In addition, approximately 3,900 parcels in the City of Lake Elsinore and surrounding areas have septic systems that are still in use (see **Figure 5-2).** Risk zones associated with septic tank locations relative to groundwater supply are presented below.

Figure 5-2
Septic Tank Risk Zones



Generally, the level of risk is related to existing or potential future groundwater supply development and recharge potential. The categories and the basis for their selection are as follows:

- **Areas of Low to Moderate Risk:** These areas generally consist of bedrock. There is little or no potential for the development of groundwater supply projects in these areas.
- **Areas of Moderate to High Risk:** These are areas where there are existing groundwater supply facilities or the potential for the development of future groundwater supply. However, the clay content is higher in the shallow sediments which provides limited separation between septic tank effluent and the deeper water supply aquifers.
- **Areas of High Risk:** These are areas where there are existing groundwater supply facilities or the potential for future groundwater supply development. Based on the location relative to the basin boundaries, and the lack of fine-grained sediments in the shallow sediments, these areas are where most of the aquifer recharge occurs and are the most vulnerable to contamination.

One of the eight EVMWD wells (Palomar) and two of EWD's wells (Wood and Sanders) are currently located in high risk zones. As discussed in Section 2, the Palomar well has experienced an increase in nitrate concentrations (an indicator parameter for contamination from septic tanks or previous agricultural use) over the past 15 years. If nitrate concentrations in this well continue to increase, it is possible that it could exceed the MCL of 45 mg/L in the near future. Sufficient data are not available to evaluate the nitrate concentrations in the Wood and Sanders wells. Although concentrations are currently below the MCL of 45 mg/L for nitrate in these wells, nitrate presents an issue for groundwater quality in portions of the basin.

An additional concern for contamination is from leaky underground storage tanks (LUSTs) discharging petroleum products, solvents or other organic constituents. In particular, the gasoline oxygenate known as MTBE (methyl tertiary-butyl ether) has become a major problem throughout California. Thirty-five cases of LUSTs have been reported to the RWQCB (RWQCB, 2003). Cleanups are currently underway or completed for these locations. According to the RWQCB, MTBE has been detected in the groundwater as a result of LUSTs in four locations throughout the Elsinore Basin since 1998. Based upon recent groundwater production well quality data, no District or EWD well has had detections of MTBE or other organic compounds attributed to these LUSTs.

4. Well Construction Policies

Because improperly constructed wells can impact water quality, proactive policies to ensure proper construction are an important aspect of the GWMP. Well construction policies are addressed later in this document under Groundwater Management Strategies and Activities.

5. Well Abandonment and Destruction

Improperly abandoned or uncapped wells can provide a vertical conduit for surface contaminants into the groundwater. Therefore, proactive involvement by EVMWD is necessary to help promote groundwater protection practices. Well abandonment policies are addressed later in this document under Groundwater Management Strategies and Activities.

6. Construction of Groundwater Projects

One of the AB3030 requirements is to evaluate the impact of the construction and operation of various projects on the groundwater basin water quality and quantity. Projects mentioned include:

- Groundwater contamination cleanup projects (discussed above)
- Groundwater storage projects
- Groundwater recharge projects
- Groundwater extraction projects
- Water conservation projects
- Water recycling projects

Groundwater Storage Projects

One of the main objectives of the GWMP is to evaluate the possibilities of groundwater storage to provide additional water supplies in dry periods and thereby improving water supply reliability. Groundwater storage and recovery may result in greater fluctuations of water levels and a potential change in water quality in the aquifers used for storage. Water level changes may lead to a risk of subsidence or liquefaction.

Groundwater Recharge and Extraction Projects

For groundwater recharge, surface recharge, direct injection, and in-lieu recharge are considered and evaluated in this GWMP. To identify potential surface recharge locations, EVMWD is currently conducting a study to evaluate the feasibility of surface recharge in the Elsinore Basin. In addition, EVMWD is performing the BBIPP to assess the benefits of injecting imported water in the underlying aquifers in the Back Basin area. Both projects will provide EVMWD with additional information on potential technical and management issues with regards to these activities.

Water Conservation Projects

Water conservation is an approach to reduce potable water demands, and thereby providing part of the solution for the projected water supply deficit. Many water conservation methods such as low flow toilets, water saving clothes washers and low flow showerheads, do not significantly impact the groundwater basin because water conservation will reduce the demand for imported water, while pumping will remain essentially constant. However, conservation focused on a reduction of irrigation water use may result in reduced infiltration that replenishes the groundwater basin. Therefore, a portion of the conserved water may not return to the basin and must be considered when evaluating water conservation programs.

Water Recycling Projects

EVMWD is currently conducting a pilot study that evaluates the effect of discharging recycled water to Lake Elsinore on water quality with the ultimate intent of obtaining a National Pollutant Discharge Elimination System (NPDES) permit. This pilot study is scheduled to be completed in February 2004. If the use of recycled water to maintain lake levels is approved, the amount of groundwater that will need to be pumped from the groundwater basin into the lake will decrease. The amount of wastewater effluent available for lake augmentation depends on the waste discharge requirements, the required minimum discharge to Temescal Wash, future demand for non-potable water and availability of recycled water from EMWD. In addition, recycled water may also be used for landscape irrigation, which will increase the salt concentration within the groundwater basin. The current regional treatment capacity is 8 mgd, which is planned to be expanded 20 mgd by year 2020.

7. Impact of Land Use Plans on Groundwater Contamination

Land use plans were obtained during the preparation stages of the Distribution System Master Plan (MWH, 2002). EVMWD will continue to interact with planning agencies, including the City of Lake Elsinore and Riverside County to obtain land use plans, track future developments and identify potential water quality impacts on the groundwater basin, as well as determine future utility service needs.

8. Mitigation of Overdraft Conditions

The contemporary definition of *overdraft* incorporates an evaluation of the consequences of extracting more groundwater from a basin than is returned. The *perennial yield* of a groundwater basin defines the rate at which water can be withdrawn perennially under specific operating conditions without producing an undesired result (e.g., water quality degradation, land subsidence, or declining water levels). Any production in excess of perennial yield is regarded as overdraft. The existence of overdraft implies that continuation of current water management practices will result in significant adverse impacts on environmental, social or economic conditions (Todd, 1980; American Society of Civil Engineers, 1987).

Groundwater Balance and Water Levels

A groundwater balance, which accounts for the inflows and outflows in the basin, illustrates the extent of groundwater overdraft. From 1990 through 2000, the average annual groundwater storage decreased by about 1,800 acre-ft/yr (as discussed in Section 2). It should be noted that this period was wetter than the historical average and, as such, may underestimate the actual deficit in the basin. In addition, water levels in some wells in the south portion of the basin declined more than 200 feet from 1990 to 2000. Groundwater levels remained fairly constant in the northern part of the basin where most of the recharge occurs.

As discussed in Section 4, the projected future groundwater balance indicates continued decline in water levels and continued overdraft conditions in the basin if current groundwater activities are continued. The average groundwater deficit is projected to be about 4,400 acre-ft/yr if existing conditions (Baseline A) continue and more than 6,500 acre-ft/yr with projected increases in groundwater use (Baseline B). Because of the negative groundwater balance and declining water levels, the sustainability of this condition is a significant issue for this GWMP.

Risk for Land Subsidence

Land subsidence is the lowering of the ground surface due to groundwater withdrawal or seismic activity. Seismic-induced movements may cause subsidence on the depressed side of a fault, or relatively small-scale subsidence can also occur when dry soils are saturated with water due to seismic activity. Groundwater withdrawal is the most likely mechanism or cause for land subsidence in the Elsinore Basin. Groundwater withdrawal causes the sediments of the aquifer to consolidate. The amount of consolidation depends upon the thickness and hydrogeologic character of the aquifer, as well as the rate and amount of decrease in the water level. Fine-grained sediments (clays), such as those composing the aquitard that separates the alluvium and the Fernando Group, are more susceptible to consolidation and subsidence than coarse-grained sediments (sands and gravels) when groundwater is removed from them. However, the low permeability and high specific storage of fine-grained sediments cause consolidation to occur slowly, over a period of several years, rather than as an instantaneous response to water level decline. Therefore, a short-term impact might be difficult to detect and subsidence may occur years after the water level had declined. However, once the consolidation occurs, consolidation of fine-grained sediments is permanent, due to a permanent rearrangement of soil particles. This results in a permanent loss of groundwater storage capacity and causes permanent land subsidence.

Uneven depression of the land surface is the major indication of vertical consolidation due to surface subsidence. Land subsidence due to vertical consolidation usually is not uniform, possibly due to differences in the underlying sediments. The resulting damage can include:

- Visible cracks, fissures, or surface depressions
- Damage to structures, such as canals, utilities, roads, and buildings
- Damage and loss in effectiveness of the subsurface agricultural drainage system
- Disruption of surface drainage and irrigation systems
- Loss of vertical elevation

In addition to vertical consolidation, regional and local horizontal ground movements can occur due to large amounts of localized groundwater extraction. The horizontal movements can ultimately result in inelastic failures at the ground surface that appear as surface fissures. Surface fissures can damage structures, interrupt irrigation of agriculture, capture runoff, and can become direct conduits for poor quality water to enter the aquifer. The risk of subsidence is a potential issue for EVMWD as water levels have been decreasing over the past ten years and the use of groundwater is projected to increase in the future.

9. Replenishment of Extracted Groundwater

As discussed in the water budget of Section 4, average annual inflow to the Elsinore Basin total approximately 5,700 acre-ft/yr based upon 1961-2001 hydrology in 2020. In the northwest portion of the basin, the inflow over the past ten years has been in approximate balance with the outflows. However, the water levels in the southern part of the basin have been declining, which suggests that the replenishment has been lower than the groundwater extraction. Maintaining water levels within an acceptable range is an objective of the GWMP and is incorporated in the groundwater management strategies.

Infiltrating precipitation in open and urban areas contributes approximately 2,400 acre-ft/yr, which is about 40 percent of the total inflow to the basin. Urbanization results in a loss permeable land surface, which leads to more runoff and less infiltration. It is estimated that the increased urbanization around the lake will diminish groundwater recharge due to infiltration of runoff from 900 to 700 acre-ft/yr between the present and year 2020. Due to this relatively small amount, the effect of reduced recharge is not considered a significant issue for the GWMP.

10. Monitoring of Groundwater Production, Levels, Storage, and Water Quality

EVMWD and EWD currently record the production and water levels from their existing wells monthly. In addition, water quality samples are collected on an annual basis. The basin contains more than 200 wells, most of which are operated by private well owners. Groundwater pumpers extracting more than 25 acre-ft on an annual basis are required to file their production with the SWRCB per Water Code §5001. However, this reporting is not comprehensive and, for most producers, occurs on an irregular basis. Additional information is necessary to better identify areas of potential concern. Data currently available are discussed in more detail in Section 2.

An understanding of the water quality throughout the basin is also an important aspect of groundwater management. Water quality information is required to evaluate the existing basin conditions and the compatibility with imported water supplies, as well as to monitor the changes in water quality as a result of the proposed groundwater management activities such as surface infiltration and direct injection of imported water. The Groundwater Monitoring Plan (MWH, 2003) has specified the recommended parameters, locations, and frequency for water quality and water level monitoring.

11. Facilitating Conjunctive Use Operations

Conjunctive use is the practice of storing surface water in a groundwater basin in wet periods and withdrawing it from the basin in dry periods. The goal of conjunctive use is to improve water supply reliability. Conjunctive use will be part of all management strategies, and is discussed in more detail in Section 6.

12. Develop Relationships with Regulatory Agencies

Early participation of agencies and stakeholders will provide the opportunity to include their concerns in the GWMP and is important to avoid any unanticipated issues and ease the implementation process. Stakeholders and regulatory agencies have been invited to participate in the GWMP development process via the formal stakeholder meetings. Continued involvement will be necessary.

Other Management Issues

In addition to those issues addressed in AB3030, there are other groundwater management issues or components that are considered in this GWMP.

1. Compliance with Drinking Water Quality Regulations and Basin Plan Objectives

Existing areas of concern relative to drinking water quality regulations and the Basin Plan Objectives in the Elsinore Basin include:

- Concentrations of TDS have exceeded the DHS-recommended secondary standard of 500 mg/L in the Lincoln Street Well and Cereal 4 Well.
- Concentrations of nitrate and sulfate, although higher in some locations, have not exceeded applicable standards in any EVMWD well.
- Concentrations of arsenic are below the current MCL of 50 µg/L, however, they have exceeded the new (effective 2006) MCL of 10 µg/L in the Back Basin wells (Cereal 1, Cereal 3, Cereal 4 and Corydon Street).
- Highest concentrations of arsenic are found in deeper wells such as Cereal 1, Cereal 3 and Cereal 4.

According to EVMWD staff, the Olive Street well is not currently in production because of elevated bacterial levels. These elevated levels may be caused by a variety of environmental conditions including the influence of septic tanks and surface water and/or operating conditions such as vegetable oil leakage within the pump. Because the elevated bacteria levels are not associated with a corresponding increase in nitrate concentrations or other nutrients, it is unlikely to be caused by septic tanks alone. Further investigation will be required to address this issue.

Future use of EVMWD wells will depend upon the active management of water quality with respect to TDS, nitrate, arsenic and bacteria. Blending options may need to be addressed. As discussed previously, the future risk of contamination from septic tanks and LUSTs should also be considered.

Table 5-2 summarizes the specific water quality objectives set for the Elsinore Basin by the RWQCB (1995). For the water quality objectives of the Basin Plan is more stringent that the Title 22 drinking water regulations. It should be noted that Regional Board is currently revising the Basin Plan objectives. The proposed revision limits the Basin Plan objectives to two parameters, TDS and nitrate (as N) with maximum concentration of 480 mg/L and 1 mg/L, respectively. These revisions are expected to be adopted in 2004. Future groundwater management activities will need to be consistent with these objectives and regulations. With current TDS concentrations of about 550 mg/L in the upper aquifer, this parameter is a groundwater management concern, as TDS concentrations tend to increase over time due to continuous addition of salt through natural recharge, septic tank infiltration, injection of imported water, or surface spreading of imported water.

2. Doubling of Water Demand in the Next 20 Years

As discussed in Section 1, water demands in the Elsinore Basin are projected to more than double by 2020. The increasing water demands in EVMWD's water service area result in the need for additional water supplies by 2020. This issue is one of the driving forces behind the GWMP.

Table 5-2
Specific Water Quality Objectives for Elsinore Basin

Constituent	Units	Basin Objective	Drinking Water Standards
Elsinore Basin			
Total Dissolved Solids	mg/L	450 , 480[2]	500[1]
Hardness	mg/L	260	NS
Sodium	mg/L	50	NS
Chloride	mg/L	60	250[1]
Sulfate	mg/L	60	250[1]
Nitrate (as N)	mg/L	4,1[2]	10
San Jacinto River			
Total Dissolved Solids	mg/L	450	500[1]
Hardness	mg/L	260	NS
Sodium	mg/L	50	NS
Chloride	mg/L	65	250[1]
Sulfate	mg/L	60	250[1]
Total Inorganic Nitrogen	mg/L	3	NS
COD	mg/L	15	NS
Lake Elsinore			
Total Dissolved Solids	mg/L	2,000	500[1]
Total Inorganic Nitrogen	mg/L	1.5	NS
Canyon Lake			
Total Dissolved Solids	mg/L	700	500[1]
Hardness	mg/L	325	NS
Sodium	mg/L	100	NS
Chloride	mg/L	90	250[1]
Total Inorganic Nitrogen	mg/L	8	NS
Sulfate	mg/L	290	250[1]

Source: Regional Board, 1995.
1 – Secondary Maximum Contaminant Level (MCL) of California
2 – Proposed Basin Plan Objective for Elsinore Basin (RWQCB, pers. comm, 2003)
NS = No standard

With the potable water demands doubling over the next 20 years and limited groundwater resources, the reliance on imported water will increase. Based on the water source allocation of the Distribution System Master Plan (MWH, 2002), imported water will be 80 percent of the water supply in year 2020. As the need for imported water increases throughout Southern California, the reliability of this source is critical for EVMWD's water supply.

3. Lake Replenishment Requirements

As discussed previously, the target minimum level for Lake Elsinore is 1,240 feet MSL. To maintain this level, the volume of additional water required from either groundwater or required for lake augmentation varies from zero to more than 12,500 acre-ft/yr. A more detail analysis is included in **Appendix E**.

Replenishment water can be obtained from groundwater, recycled water, or untreated imported water. EVMWD is currently conducting a pilot study to evaluate the effect of discharging recycled water on the lake's water quality. Untreated imported water is costly, but may be more economical than groundwater. When groundwater is used for lake augmentation, groundwater overdraft increases. To prevent the overdraft impacts, additional imported water is necessary for groundwater replenishment or to meet demands. Therefore, the use of groundwater for lake replenishment results in the purchase of more treated imported water to meet potable water demands and may be less cost-effective than using other sources of water for lake replenishment.

4. Impact of Future Basin Operations on Hot Springs

Through discussions with stakeholders in the basin, the impact of the GWMP on local hot springs is identified as a potential issue in the basin. Within the EVMWD service area, wells with hot water are located along the outflow channel from Lake Elsinore to Silver Street. The heated water associated with the faulting in the area rises to shallow depths near downtown Lake Elsinore north of the Glen Ivy fault. Because the Glen Ivy fault appears to be a barrier to flow at this location, activities in the Elsinore Basin are not anticipated to influence the hot spring operations.

5. Risk of Liquefaction

Liquefaction is a process by which sediments below the water table temporarily lose strength and behave as a liquid rather than a solid. In the liquefied condition, soil may deform enough to cause damage to buildings and other structures. Seismic shaking is the most common cause of liquefaction. Liquefaction occurs in sands and silts in areas with high groundwater levels. Liquefaction has been most abundant in areas where groundwater occurs within 30 feet of the ground surface; few instances of liquefaction have occurred in areas with groundwater deeper than 60 feet (EERI, 1999). Dense soils, including well-compacted fills, have low susceptibility to liquefaction (EERI, 1999).

The risk for liquefaction in the Elsinore Basin is the highest in areas where groundwater levels in the alluvium are shallow. This primarily occurs in the Back Basin area but may also occur in other locations if water levels were to rise to within 30 feet of the ground surface. Storing groundwater in the basin that results in higher groundwater levels may increase the risk of liquefaction. The GWMP needs to establish the maximum water levels to minimize the risk of liquefaction.

GROUNDWATER MANAGEMENT STRATEGIES AND ACTIVITIES

A groundwater management strategy is a general approach that addresses one or more of the management issues. The strategies identified are:

- Store imported water by using dual purpose wells
- Increase local supplies by using spreading basins
- Store imported water by using spreading basins
- Save groundwater for dry years by using in-lieu recharge
- Develop new sources of supply
- Reduce supply needs through water conservation
- Measure progress through basin monitoring
- Stakeholder involvement
- Protect groundwater quality by developing programs and policies

The management activities are presented per strategy in **Table 5-3**, which also includes the source(s) of water considered for each activity. These strategies and corresponding activities are explained below.

Dual Purpose Wells

Dual purpose wells are wells that can both inject water into and extract water from the aquifer. Depending on the difference between the distribution system and the aquifer pressures, water can either flow by gravity into the aquifer or needs to be pumped during injection cycles. Wells can be used to inject water in periods when imported water may be available in large amounts or at lower cost. During dry periods, when less imported water may be available or the cost of imported water is high, the wells can be used to extract the stored water from the aquifer.

The design of injection wells is similar to that of a water supply well. Because water is injected directly into the aquifer, this method bypasses the unsaturated zone and any intervening low permeability layers and eliminates evaporation losses. Therefore, injection wells are advantageous in regions where shallow clay layers are present that prevent good infiltration. However, because water is injected directly into a drinking water aquifer, water used for injection needs to meet drinking water regulations prior to injection as specified under CFR 144.12a (EPA, 1999). Therefore, the only water sources available for injection are treated imported water from MWDSC and water from the Canyon Lake WTP.

Possible Locations

Locations considered for dual purpose wells, which are provided in **Figure 5-3,** include:

- North of the lake between Lakeshore Drive and Grand Avenue and
- South of the lake within the Back Basin

Table 5-3
Management Activities and Water Sources Considered

Strategy	Activity	Existing Sources			New Sources		
		Imported Water from TVP[1]	Imported Water from AVP[2]	Canyon Lake WTP[3]	Recycled water from RWWTP[4] or EMWD[5]	Imported Water from SJRT[6]	Sewering of Septic Tanks
Store imported water by using dual purpose wells	Dual purpose wells north of the Lake	X	X	X	-	-	-
	Dual purpose wells south of the Lake	X	X	X	-	-	-
Increase local supplies and store imported water by using surface spreading basins	Spreading basins in McVicker Canyon	X	X	-	X	X	X
	Spreading basins in Leach Canyon	X	X	-	X	X	X
	Surface recharge in Railroad Canyon	-	-	-	-	X	-
Save groundwater for dry years by using in-lieu recharge	In-lieu recharge with imported water	X	X	-	-	-	-
	In-lieu recharge with Canyon Lake WTP water	-	-	X	-	-	-
Other Strategies • Develop new sources of supply • Reduce supply needs through water conservation • Measure progress through basin monitoring • Stakeholder involvement • Protect groundwater quality by developing programs and policies							

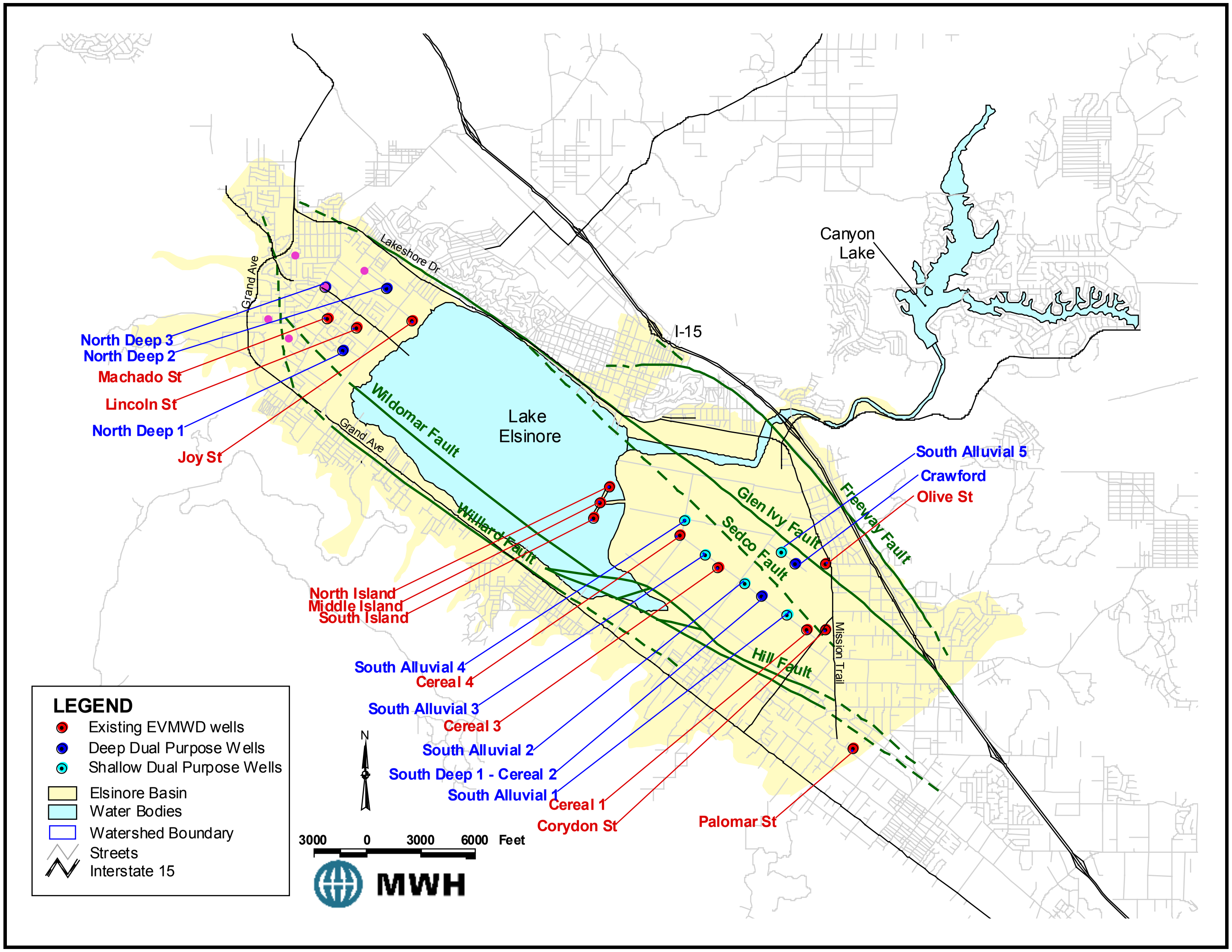
1 - Temescal Valley Pipeline, 2 - Auld Valley Pipeline, 3 - Water Treatment Plant, 4 - Regional Wastewater Treatment Plant,
5 - Eastern Municipal Water District, 6 - San Jacinto Untreated Water Turnout, "X" means considered and "-" means not considered.

Recharge Potential

Three dual-purpose wells are considered in the area north of the lake. Details are as follows:

- Three deep dual purpose wells (up to 1,000 feet)
- Extraction capacity of deep wells would be 1,000 gpm per well
- Injection capacity of deep wells would be 750 gpm per well

Figure 5-3
Location of Dual Purpose Wells



Eleven dual-purpose wells are being considered within the Back Basin area. Details are as follows:

- Six deep (up to 1,000 feet) and five shallow (less than 500 feet) dual purpose wells.
- Three of the deep wells would be existing wells converted to dual purposed wells, these are Cereal 1, Cereal 3, and Corydon. The remaining three deep wells would be new wells.
- Extraction capacity of deep wells would range from 1,000 gpm to 1,750 gpm
- Injection capacity of deep wells would range from 750 gpm to 1,400 gpm per well
- Extraction capacity of shallow wells would be 700 gpm per well
- Injection capacity of shallow wells would be 350 gpm per well

These capacities are based upon preliminary results of the BBIPP. Details of these wells are summarized in **Table 5-4**. When available, up to about 11,750 acre-ft/year of imported water could be injected using dual-purpose wells. These wells could extract up to about 13,100 acre-ft/yr.

Operation

Dual-purpose wells are operated in cycles of injection and extraction. Water that could be used for injection is treated water from Canyon Lake WTP and treated imported water from MWDSC. Because the connection with the TVP is closer to the area north of the lake than the AVP connection, the injected water would primarily originate from the TVP for wells north of the Lake. For wells in the Back Basin, injected water may come from either the TVP or the AVP. Injection would take place in low demand periods (typically October through March) when lower cost replenishment water is available and the water distribution system can accommodate the extra water demand for the injection wells without resulting in low system pressures.

Table 5-4
Summary of Recharge Potential with Dual Purpose Wells

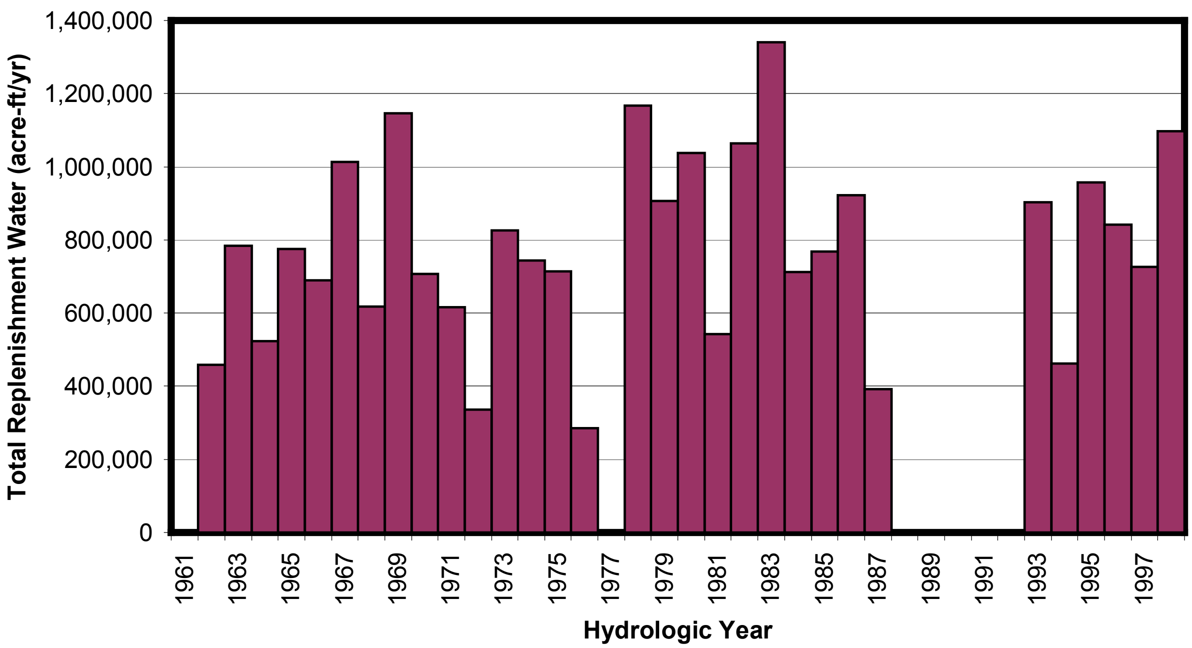
Area	Number of Wells	Maximum Injection Capacity (gpm)	Maximum Extraction Capacity (gpm)	Annual Injection Potential[1] (acre-ft/yr)	Annual Extraction Potential[1] (acre-ft/yr)
North of Lake					
Deep Wells	3	750	1,000	600 per well	810 per well
Back Basin					
Shallow Wells	5	350	700	280 per well	560 per well
Deep Wells	5	1,400	1,750	1,130 per well	1,410 per well
Deep Wells	1	750	1,000	600 per well	810 per well
Total	**14**	**11,750**	**16,250**	**11,750**	**13,100**

1 – Calculations assume continuous extraction/injection during six months per year.

Based on information provided by MWDSC, replenishment water is expected to be available for injection in approximately eight out of ten years. **Figure 5-4** shows the projected amount of replenishment water available in year 2020 based on hydrologic conditions from 1961 through 1998.

Injection is assumed to take place during six months from October through March. It should be noted that injection may be possible year around during wet years if excess replenishment water is available. The extraction periods depend on the need for stored groundwater. In years that the summer demand can be met with the existing groundwater wells and imported water, the dual-purpose wells would not extract any long term stored water. However, in dry years when existing supplies cannot meet the summer demand peak, the dual-purpose wells would be used to extract stored water from the groundwater basin. To exercise all the wells regularly, cycling the use of dual-purpose wells for extraction along with the regular production wells is recommended.

Figure 5-4
Total Replenishment Supplies Available from MWDSC (1961-1998)



The operation of dual-purpose wells south of the lake would be the same as the dual purpose wells in the north part of the basin. Injection in the area south of the lake is would be with water from the AVP connection due to the closer proximity.

Implementation

Implementation of dual-purpose wells north of the lake would include the design and construction of three wells. Environmental documents are currently being prepared and permits (such as Waste Discharge Requirements) would need to be prepared prior to construction. One well with injection capabilities should be constructed and tested before designing, constructing or converting a second well.

The implementation of dual-purpose wells south of the lake would require the design and construction of seven wells. Environmental documents and permits would need to be prepared prior to construction.

Surface Spreading

Surface spreading is the process of infiltrating water into the groundwater aquifer using ponds or ditches. These spreading facilities are open areas with highly permeable soil to allow rapid infiltration by gravity. Infiltration rates vary based on the soil type and the depth of the water in the spreading basin, but typically range from less than one to six feet per day in areas suitable for surface recharge. Surface spreading can be used for surface runoff, recycled water, or other sources such as imported water.

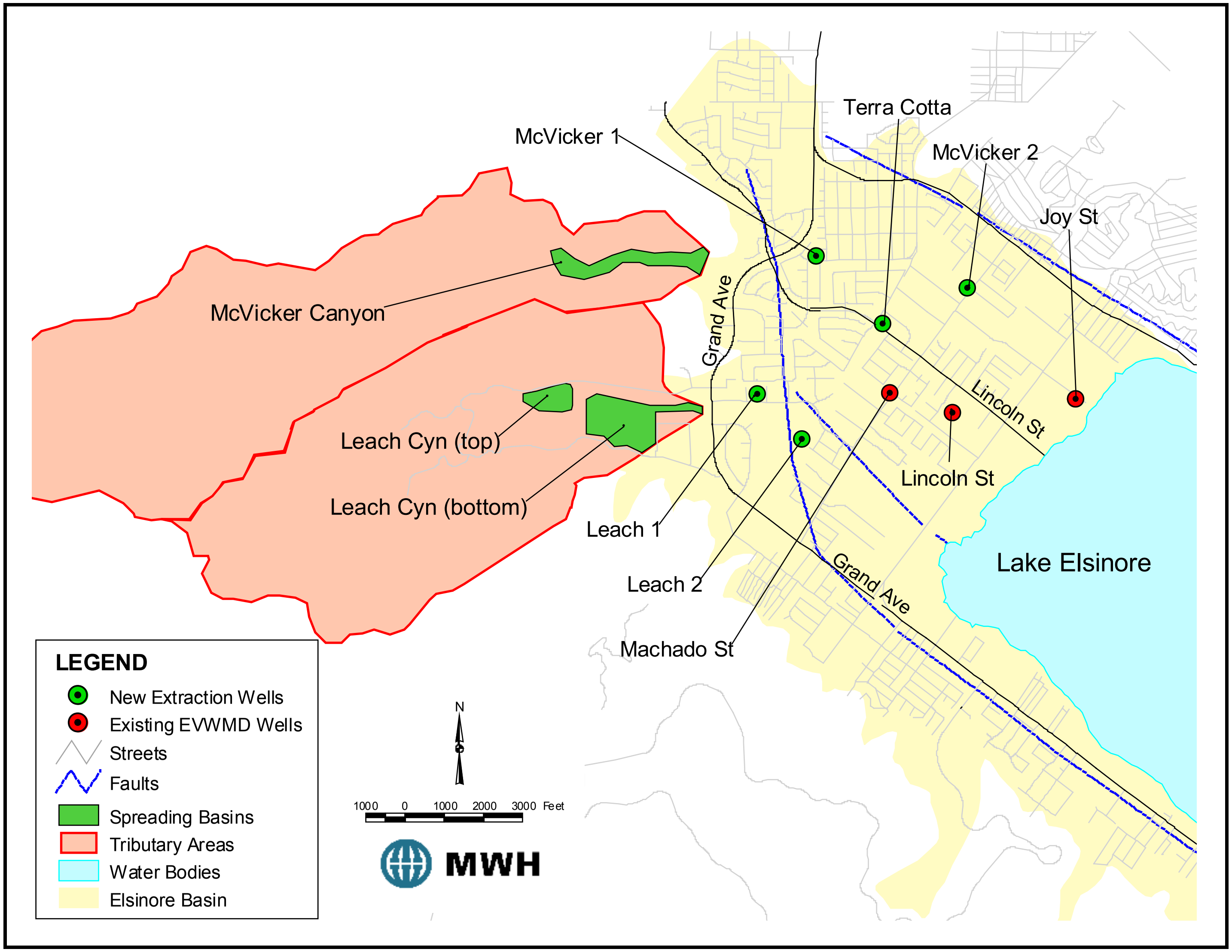
Many different types and sizes of spreading facilities exist. The size is dependent upon the available land and the amount of water that needs to be captured. A spreading facility is typically divided into multiple ponds or basins that are separated with earthen berms. The ponds are often interconnected and are terraced to allow water to flow from one basin to the next. The number of available basins further limits the effective spreading area because regular maintenance is required to sustain high infiltration rates. The water level in the spreading basins should not exceed more than five feet because the weight of the water compacts the soil, which limits the infiltration rate. Low water levels at the other hand result in lower infiltration rates due to lower water pressures.

Spreading basins are the most common method of groundwater recharge because they are relatively inexpensive if adequate land is available. However, this method is not suitable in areas where surface clay is present because these clays limit downward infiltration. In the Elsinore Basin, surface spreading is most suitable along the margins of the Elsinore Basin where substantial clay is absent. In addition, the San Jacinto River, where the groundwater aquifer is naturally recharged, is also a suitable location for surface recharge. At these locations, the infiltration of local runoff can be maximized, reducing the amount of imported water required for recharge.

McVicker Canyon

One site for proposed surface spreading is located within City of Lake Elsinore, near the intersection of Grand Avenue and Lincoln Street. The site encompasses the eastern portion of the McVicker Canyon bottom, and includes a portion of the existing flood control basin and drainage facilities maintained by Riverside County Flood Control and Water Conservation District (RCFCWCD). The flood control basin includes an earthen dam situated across the upper mouth of the McVicker Canyon. Along the southwestern margin of the site, an apparently natural seep flows in and drains into the basin area. The McVicker Canyon site and the Leach Canyon site are shown in **Figure 5-5**.

Figure 5-5
Potential Recharge Locations



Recharge Potential

The recharge potential for McVicker Canyon is summarized in **Table 5-5**. Based upon available land area in the vicinity of McVicker Canyon, as much as 800 acre-ft/yr could be infiltrated (assuming an infiltration rate of approximately 1 foot per day) with minor modification of the existing debris basins in an area of approximately 9 acres. If additional recharge were required, the basins could be expanded to infiltrate as much as 2,000 acre-ft/yr.

Implementation

Implementing surface spreading at McVicker Canyon would require grading of the entire site to provide infiltration surfaces and berms to separate the individual ponds. Pipelines from either the intersection of Broadway Avenue and Grand Avenue or Railroad Canyon Dam would need to be constructed as well as a booster station if water from Canyon Lake is used for surface spreading. Specific details of the spreading operations and actual amounts infiltrated under each alternative will be discussed later in the description of each alternative.

For the design of the spreading facilities, it is important to have a good understanding of the recharge characteristics of the soils. Although a good understanding of the Elsinore Basin geology has been obtained, more understanding is on the following topics is desired before spreading facilities can be designed:

- The infiltration rate and basin geometry along the San Jacinto River between Canyon Lake and Lake Elsinore
- The infiltration rate and transport characteristics and depth to bedrock in the vicinity of Leach and McVicker Canyons

Table 5-5
McVicker Canyon Surface Spreading Potential

Parameter	Minimum Size	Expanded Size
Total Site Area (acres)	9	22
Wetted Area (acres)	6	15
Annual Infiltration from Runoff (acre-ft/yr)	200	400
Infiltration from Imported Source (acre-ft/6 months)	600	1,600
Total Annual Infiltration Volume (acre-ft)	800	2,000
Availability of Imported Water	6 months; October through March 67 percent use factor	6 months; October through March 67 percent use factor

More data should be collected from pilot tests of surface spreading for the canyon(s) selected as part of the preferred management alternative to obtain information required for a detailed design.

Leach Canyon

Leach Canyon is located within the unincorporated part of Riverside County within the City of Lake Elsinore's sphere of influence. The site consists of two portions. The top portion includes the lower part of the flood control basin located within Leach Canyon, and is bordered to the east by the debris dam at the mouth of the canyon. The location of this site is depicted in Figure 5-5. The north boundary of the site is Leach Canyon Road, which becomes Amorose Street at the intersection point with the dam. The bottom portion consists of a narrow strip of land south of single-family residential properties along Amorose Street, abutting Grand Avenue to the east and the dam to the west. This portion contains an earthen channel that drains from the flood control basin behind the debris dam to Grand Avenue, where it joins another drainage channel.

Recharge Potential

The recharge potential for Leach Canyon is summarized in **Table 5-6**. Based upon available land area in the vicinity of Leach Canyon, as much as 1,800 acre-ft/yr could be infiltrated (assuming an infiltration rate of approximately 1 foot per day) with minor modification of the existing debris basins. If additional recharge were required, the basins could be expanded to recharge as much as 3,300 acre-ft/yr. Specific details of the spreading operations and actual amounts infiltrated under each alternative will be discussed later in the description of each alternative.

Table 5-6
Leach Canyon Surface Spreading Potential

Parameter	Minimum Size	Expanded Size
Total Site Area (acres)	21	38
Wetted Area (acres)	14	25
Annual Infiltration from Runoff (acre-ft/yr)	300	500
Infiltration from Imported Source (acre-ft/6 months)	1,500	2,800
Total Annual Infiltration Volume (acre-ft)	1,800	3,300
Availability of Imported Water	6 months; October through March 67 percent use factor	6 months; October through March 67 percent use factor

Three sources of water may be used for surface spreading: treated imported water from the TVP, untreated imported water, or recycled water from the Regional WWTP. Specific details on the required transmission pipelines and pumping stations to deliver water from these sources to the spreading basins is discussed under Alternative 2.

Operation

Imported water would be available six months per year for supplementing rainfall to provide groundwater recharge. Water could be imported from the TVP, the San Jacinto River, or potentially the Regional WWTP. The ponds would be available for infiltration of imported water approximately 67 percent of dry weather days to allow for wetting and drying cycles. Volume would be reserved to provide detention of runoff in the event of a storm. During rain events, they would be fully functional. The ponds would be available for maintenance during periods of inactivity. Based on preliminary calculations, it appears that the anticipated annual infiltration volumes of water at Leach Canyon would not cause excessive groundwater mounding. Pilot testing is needed to verify this assumption.

Implementation

Implementing surface spreading at Leach Canyon would require grading of the entire site to provide level infiltration surfaces and berms to separate the individual ponds. The pipelines from either the intersection of Broadway Avenue and Grand Avenue or Railroad Canyon Dam would need to be constructed as well as a booster station if water from Canyon Lake is used for surface spreading. Prior to implementation, pilot tests should be performed to determine the long-term infiltration rates of the soils in the Canyon. The objectives of the pilot test are mentioned under the implementation of McVicker Canyon.

Railroad Canyon

The site for proposed surface recharge in Railroad Canyon is located within the City of Lake Elsinore, near the intersection of Interstate 15 (I-15) and Railroad Canyon Road. The site resides within the San Jacinto River channel along Railroad Canyon road, and includes the riparian/flood plain area, and is approximately bounded by Railroad Canyon Road to the south, I-15 to the west, and Newport Road to the north. The river passes beneath the Summerhill Road bridge at the junction of the two portions.

Recharge Potential

The infiltration site consists of 51 acres of existing riverbed, located just downstream of USGS stream gauge 11070500. Modification of the existing riverbed to create a spreading facility has environmental constraints that would need to be mitigated when constructed. Without modification, a maximum of 30 acre-ft per day could be infiltrated, assuming an infiltration rate of 0.6 feet per day. Due to the finer grained soils present, the infiltration rate here is believed to be lower than in the canyon sites.

Operation

The proposed infiltration site is the existing riverbed. Preliminary calculations indicate that river flows less than ten acre-ft per day (5 cfs) delivered to the spreading site will not reach Lake Elsinore; thus up to this amount could be infiltrated for groundwater recharge. Once the infiltration capacity of the riverbed is reached, water flows into Lake Elsinore. The source of water for spreading would be Canyon Lake, which feeds the San Jacinto River below Canyon Lake in wet weather, when water is released from the Railroad Canyon Dam or when the lake spills. The lake level could be maintained at the spillway elevation to achieve continuous recharge by purchasing untreated imported water. It should be noted that some losses of water will occur while the water flows through the 12-mile stretch of the San Jacinto River north of Canyon Lake. These losses are estimated to range between 6 and 16 percent (MWH, 1997). Other losses would be the increased evaporation from Canyon Lake due to an increase lake surface area when the lake is full.

Implementation

The existing riverbed would not require modification to implement the surface recharge concept.

In-Lieu Recharge

The concept of in-lieu recharge involves the replacement of groundwater pumping with imported water supplies. With an in-lieu operation, water users that currently pump groundwater would maximize the use of imported water during wet periods (either seasonally or annually) when more imported water may be available. Groundwater pumping would be limited during these periods. During dry periods, the users would pump groundwater using existing facilities. Groundwater recharge occurs during the wet periods as groundwater accumulates instead of being pumped out of the basin. The amount of in-lieu recharge that can be implemented in the Elsinore Basin is dependent upon the demand and the capacity of existing facilities.

EVMWD is the principal groundwater producer in the Elsinore Basin, EVMWD is responsible for approximately 95 percent of the total groundwater pumping in the basin. Implementation of in-lieu recharge by EVMWD would not require any major facilities as the water distribution system has two imported water connections. However, some groundwater pumping will be required to provide peaking capacity. If individual pumpers or Elsinore Water District (EWD) are included in in-lieu operations, imported water can be supplied to these users through the EVMWD distribution system.

New Sources of Supply

The strategy of developing new supply sources involves expanding the mix of available water to make EVMWD's water supply more flexible and reliable. The following new supply sources were identified in discussions with District Staff and the stakeholders:

- Untreated imported water from MWDSC's San Jacinto Raw Water Turnout (WR-18B)
- Runoff from the local watershed
- Recycled water from the Regional WWTP
- Recycled water from Eastern Municipal Water District (EMWD)
- Recycled water produced by connecting existing septic users to sewer

San Jacinto Raw Water Turnout

The SJRWT is located north of Avenue B and 10th Street in the City of Lakeview near Lake Perris. This 50-cfs MWDSC connection (WR-18B) can deliver untreated Colorado River water into the San Jacinto River. From the turnout point, water travels approximately 12 miles downstream to Canyon Lake. Before the AVP was built, this connection was used to deliver water into Canyon Lake that fed the Canyon Lake WTP. Because EVMWD can purchase treated imported water at the AVP connection, this connection has not been used regularly to feed the Canyon Lake WTP. Currently, the Canyon Lake WTP only treats natural runoff from the San Jacinto River watershed. Untreated imported water from the SJRWT can be used as a supply source for surface spreading or for lake replenishment.

Surface Spreading

Untreated imported water from the SJRWT can be used for either surface recharge in the San Jacinto River or surface spreading in local canyons. As discussed previously, McVicker and Leach Canyons have the best recharge potential. However, spreading imported water at these locations would require construction of an untreated water pipeline from the dam to the spreading basins. Another option is a pipeline from the outlet of the San Jacinto River into Lake Elsinore

Lake Replenishment or Augmentation

Untreated water from the SJRWT can also be used for lake replenishment reducing the amount of groundwater that needs to be utilized for lake augmentation. Although the cost of untreated imported water is higher than the cost of groundwater, the use of untreated water for lake replenishment may be more cost effective than the use of groundwater when the total costs of water supply are considered. When high quality groundwater is pumped into the lake, this water is no longer available for potable water supply. To keep the basin in balance, potable groundwater pumping would need to be reduced, resulting in the need for more treated water from MWDSC at a higher cost than the untreated imported water. The use of groundwater for lake augmentation will eventually be paid for as treated water. A secondary advantage of using untreated water for lake augmentation is the increased natural recharge in the San Jacinto riverbed. However, untreated imported water does not meet the Basin Objectives. The most cost-effective source for lake augmentation is likely to be recycled water, assuming that no additional treatment is required beyond existing processes.

Local Runoff

The capture of local runoff can be increased by the construction of surface spreading basins in the canyons and by enhanced infiltration in the San Jacinto River.

Regional WWTP

Based upon current construction and the Sewer Master Plan (Kennedy/Jenks, 2002), the Regional WWTP has a current capacity of 8 mgd and which is planned to be expanded to 20 mgd by the year 2020. This projection does not include conversion of all septic tanks to sewer system connections within the basin, hence the total available wastewater flow from the Regional WTP may be higher than anticipated. The GWMP recommends that policies be developed to regulate the installation of septic tanks for new developments as well as the conversion of existing septic tanks that are in close proximity of sewer trunk mains and sewer transmission pipes. Reducing the amount of septic tanks is the basin is beneficial for groundwater quality, possibly lake water quality, and provides additional recycled water. Recycled water can be used for irrigation, lake augmentation and possibly surface spreading.

Wastewater from EMWD

At this time, the availability of recycled water from EMWD for EVMWD's use is unknown. EMWD delivers recycled water primarily for irrigation within their service area. However, during periods of low recycled water demand, EMWD stores recycled water in reservoirs and may discharge excess recycled water through a pipeline to Temescal Wash. This excess recycled water could be used for surface spreading or lake augmentation. Additional recycled water from EMWD's Temecula plant may also be available for EVMWD use in the future. EMWD is currently constructing a pipeline to convey effluent from its Temecula Plant to Temescal Wash. The availability of this source of supply and the cost of this water should be further investigated. EVMWD is currently evaluating the use of this supply as part of the Wildomar Recycled Water Master Plan.

Water Conservation

The water demand projections used in this GWMP are based on the Water Distribution Master Plan (MWH, 2002), which does not include any water conservation measures. Water conservation could be used to reduce water consumption and decrease the need for new water supplies. Specific strategies for water conservation included in this management plan are:

- Low water use landscaping
- Increased awareness and financial incentives

These strategies are currently in place in many communities throughout California, the Pacific Northwest, and the southwestern states. They have been very successful. Agencies such as the U.S. Bureau of Reclamation and MWDSC also offer funding opportunities and other resources to agencies that want to implement water conservation programs in their communities. EVWMD is not a signatory to Best Management Practices (BMP) memorandum of understanding.

Low Water Use Landscaping

Low water use landscaping utilizes plants that have lower water needs relative to traditional turf. Low water use landscaping has been found to use approximately 42 percent less water than traditional turf (East Bay Municipal Utility District, 1992) and provide significant financial savings on labor, energy usage, fertilizer, and herbicides. It should be noted that a reduction in irrigation in the groundwater basin also would lead to reduced return flows that contribute to groundwater recharge. However, the net effect is lower water supply needs. Therefore, it would be beneficial to EVMWD if low water use landscaping is implemented throughout EVMWD service area to decrease potable water needs. Key principles of low water use landscaping can be found in **Appendix G**.

Water Savings Potential

Table 5-7 shows the projected irrigation demands for EVMWD's service area, inside and outside the groundwater basin in year 2020 and the potential water savings that could be generated from implementation of a low water use landscaping program. These calculations assume:

- 39 percent of total demand is for outdoor use, or irrigation (Urban Water Management Plan, 2000).
- Low water use landscaping is implemented in 20 percent of the parcels that are projected to be developed by year 2020.
- The water reduction achieved with low water use landscaping is 42 percent (East Bay MUD, 1992).

These policies could reduce the water demand by as much as 1,630 acre-ft/yr within EVMWD's service area, which is about three percent of the total project water demand in year 2020.

Table 5-7
Estimated Irrigation Savings with Low Water Use Landscaping

Description	Inside the GW Basin (acre-ft/yr)	Outside the GW Basin (acre-ft/yr)	Total Service Area (acre-ft/yr)
Water Demand Year 2020[1]	18,560	31,390	49,950
Irrigation Demand without low water use landscaping[2]	7,240	12,240	19,480
Irrigation Demand with low water use landscaping[3]	6,630	11,220	17,850
Projected Water Savings[3]	610	1,020	1,630

1 – Based on demand projections (MWH, 2002)
2 – Based on 39 percent outdoor use
3 – Based on a participate rate of 20 percent and 42 percent water savings for participating parcels

Implementation

The conversion of traditional landscaping to low water use landscaping needs to be implemented over time and would be easiest accomplished for new developments. The use of low water use landscaping could be encouraged by public outreach, education, and financial incentives. EVMWD could play an important role in stimulating low water use landscaping practices by providing water rate discounts. EVMWD should evaluate what other agencies have accomplished with applications of this principle.

Increase Awareness and Financial Incentives

Water conservation may be implemented at residences as well as businesses. Because all new developments (which contribute up to 50 percent of the future water demand) will have water saving devices installed, most conservation in EVMWD will be from retrofits of existing toilets, showerheads, washing machines and other equipment in residential and commercial areas.

Water Savings Potential

The estimated water conservation potential is based on the following assumptions:

- Low flow toilets in residential properties resulting in a ten percent water reduction.
- Water savings due to low flow toilets in non-residential properties is ten percent.
- Low flow showerheads and plumbing in residential properties resulting in a five percent water reduction.
- High efficiency clothes washers in residential properties result in a ten percent water reduction.
- Sensitive sprinkler systems in residential properties resulting in a five percent water reduction.
- Water savings in non-residential properties is ten percent.
- 20 percent of existing customers will install low flow toilets, water saving showerheads, adjust plumbing, use high-efficiency clothes washers, and install sensitive irrigation systems by year 2020.
- 100 percent of the future customers will have low flow toilets and water saving showerheads.
- 80 percent of future customers will use high-efficiency clothes washers and install sensitive irrigation systems by year 2020.
- The overall water savings for residential customers is assumed to be 20 percent in addition to irrigation savings, taking into consideration that customers may not implement all possible water savings devices.
- The overall water saving for non-residential customers is assumed to be 10 percent.

The assumptions used are based on water conservation studies conducted throughout the United States (Ayres, 1993-1995; EBMUD, 2002; GDS, 2000). As shown in **Table 5-8**, the estimated water savings potential is approximately 5,000 acre-ft per year or about ten percent of the projected water demands for year 2020. These saving do not include the three percent saving due to low water use landscaping as discussed previously.

Water conservation achieved through the increasing public awareness will primarily offset the need for additional imported water supplies.

Implementation

Education and financial incentives are the main strategies to achieve water conservation in residential and business environments. In addition, changes in building codes effect water conservation by requiring devices such as low flow toilets. Education of customers can be accomplished though brochures at public parks and libraries, websites, school programs, community activities and television and radio commercials. Financial incentives are an effective strategy to increase water conservation because it provides benefits for people to change their behavior, rather than requesting an effort without rewards.

Table 5-8
Estimated Water Savings with Awareness and Financial Incentives

Water Demand		Residential[1] (acre-ft/yr)	Non-Residential[2] (acre-ft/yr)	Total (acre-ft/yr)
Without Conservation	Existing Customers	20,545	2,283	22,828
	Future Customers	24,414	2,713	27,127
	Total	**44,960**	**4,996**	**49,955**
With Conservation	Existing Customers	19,723 [3,5]	2,237 [3,6]	21,961
	Future Customers	20,508 [4,5]	2,496 [4,6]	23,004
	Total	**40,231**	**4,733**	**44,964**
Water Savings	Existing Customers	822	46	867
	Future Customers	3,906	217	4,123
	Total	**4,728**	**263**	**4,991**

1 – Residential demands is 90 % of the total demand
2 – Non-residential demand is 10% of the total demand
3 – Based on 20 % participation
4 – Based on 80 % participation
5 – Based 20% water savings for participating customers
6 – Based 10% water savings for participating customers

Financial incentives could be formulated in many ways, the most common are:

- Providing discounts for customers who reduce their water consumption by a predetermined percentage.
- Providing partial rebates for customers who purchase and install water conservation technologies, such as water efficient washing machines, toilets, and showerheads.
- Tiered water rate structures.

EVMWD has already implemented a rebate program for ultra low-flow toilets and for water conserving washing machines. Rebates of up to $60 are given to customers who replace a toilet that uses 3.5 to 5 gallons per flush with one that uses 1.6 gallons per flush. These toilets result in approximate water saving of ten percent for residential customers. Through June 30, 2003, EVMWD is offering a $35 rebate to customers who replace older, high volume washers with more efficient models. These washers save approximately 20 gallons of water per load, which is approximately ten percent of residential water use. In addition, these washers reduce energy use by up to 60 percent. These incentives could be expanded to increase the participation rates in these programs. Examples of other rebate programs and implementation details are included in **Appendix G**.

Basin Monitoring

A basin monitoring program is important to better understand the groundwater basin and to measure the effects of the strategies that are implemented. In addition, basin monitoring provides a basis for effective adaptive management. Basin parameters that should be monitored can be divided into the following categories:

- Water quality (groundwater and surface water)
- Groundwater levels
- Groundwater production
- Surface water levels
- Surface flows
- Precipitation

A preliminary monitoring program is presented in the Groundwater Monitoring Plan (MWH, 2003), and includes the monitoring of the parameters listed above. The monitoring program also includes the installation of new monitoring wells, aquifer testing and land subsidence monitoring.

The information collected will ultimately lead to more efficient implementation of management strategies, as it would provide guidance for adjusting management parameters according to the results over time. The collection of background data will also provide a baseline that can be used to evaluate the success of future programs.

Stakeholder Involvement

Stakeholder involvement is an important component of a successful management plan. The management of the Elsinore Basin involves many regulatory and institutional agencies as well as the general public. Involvement of the community and local agencies early in the process is important to establish a sense of ownership of the program. Examples of agency involvement that can be part of the basin management are:

- Registration of well status and production records with the SWRCB
- Coordination and enforcement of well construction and abandonment with Riverside County and DWR
- Implementation of the basin monitoring program (described above) with EWD and the City of Lake Elsinore
- Definition and implementation of septic tank policies with the City of Lake Elsinore, Riverside County and the RWQCB
- Coordination with RCFCD to maintain dual purpose flood control-surface recharge facilities in local canyons
- Formation of a basin advisory committee that will provide oversight on basin management

Groundwater Quality Protection Programs and Policies

The following is a list of activities that should be implemented as part of each GWMP alternative to protect the groundwater quality in the Elsinore Basin:

- Develop a wellhead protection program
- Develop a well construction and abandonment program
- Develop septic tank conversion policies
- Collect and evaluate land development plans

Wellhead Protection Program

The GWMP recommends that EVMWD implement a protection plan to monitor and protect existing water sources. The recharge areas to the groundwater basin have been formed naturally and are generally located around the periphery of the basin in the undeveloped regions of the basin. These areas tend to be less visited by the public, but are not protected from public access.

This GWMP recommends that EVMWD contact the RWQCB regularly to verify that no new contaminants have been accidentally released into the groundwater basin. If a leak or spill is identified, effective control and clean-up of contaminated groundwater would be conducted by the appropriate parties. This would include a coordinated effort between the appropriate regulatory agencies involved, source control, understanding of the hydrogeology, and delineation of the contamination. The regulatory agencies may include any combination of the following: RWQCB, Department of Toxic Substances Control, U.S. Environmental Protection Agency (EPA), and EVMWD. The degree to which they participate depends on the nature and magnitude of the problem.

Well Construction and Abandonment Program

Improperly constructed wells can result in poor yields and contaminated groundwater by establishing a pathway for pollutants to enter a well from the surface, allowing communication between aquifers of varying quality or the unauthorized disposal of waste into the well. In cooperation with Riverside County (Environmental Health Department), EVMWD should ensure that all wells drilled in the groundwater basin follow the California Water Code §13700 through §13806. The well drilling contractors shall be in possession of an active C-57 Contractor's license and shall obtain a County permit for the drilling, deepening, modification, or repair of any well in accordance with Riverside County Ordinance 682.3. Minimum standards for the construction of wells are specified in DWR Bulletins 74-81 and 74-90.

The GWMP recommends that EVMWD implement a well abandonment program in cooperation with Riverside County (Environmental Health Department). The program would include the identification of abandoned or improperly destroyed wells within the Elsinore Basin and a well abandonment or capping procedure. A well canvass is recommended for the identification and registration of these wells. Wells would be evaluated and destroyed as necessary. This program would include the property owners and appropriate regulatory agencies. The property owners are responsible to assure that the wells are properly destroyed, if no future use is anticipated, or capped and maintained, if future use is anticipated as outlined in Riverside County Ordinance 682.3. Proper destruction procedures are also specified in the DWR Bulletins 74-81 and 74-90.

Septic Tank Conversion Policies

The GWMP recommends that policies be developed to regulate the installation of septic tanks for new developments as well as the conversion of existing septic tanks that are in close proximity of sewer trunk mains and sewer transmission pipes. Reducing the amount of septic tanks in the basin is beneficial for groundwater quality, possibly lake water quality, and provides a new water source.

Land Development Plans

The GWMP recommends that EVMWD implement a program to regularly collect land development plans that include areas within the groundwater basin, for example every six months. EVMWD can request that the planning agencies contact EVMWD when any permit is applied for to construct the following types of facilities: unsewered residential properties, industrial buildings, production wells, and commercial structures. The use of shallow drainage wells to dispose run-off water should not be approved for construction within the groundwater basin because of the potential for surface contaminants entering the groundwater from these types of facilities.

Activities Not Considered

One activity identified during the stakeholder involvement process that is not considered in this GWMP is to increase the Lake's spillway elevation. This activity is excluded from further discussions because of the increased risk for flooding. As discussed previously, Lake Elsinore can discharge to Temescal Wash. The flow rate can be substantial in periods of heavy rain when the runoff from the local and San Jacinto watersheds raises the lake level above the sill elevation in the outflow channel (1,255 feet MSL). This outflow could be reduced if the sill elevation is raised. A higher sill elevation would create more storage capacity in the lake. However, in a severe storm, less water would be discharged to Temescal Wash, hence increasing the 100-year flood elevation. The 100-year flood elevation has been set at 1263.3 feet MSL. It is not possible to increase the flood elevation due to developments around the lake, and therefore an increase of the spillway elevation would reduce the size of storm that could be captured in the existing flood plain. Because the 100-year flood elevation is fixed, the increase of the spillway is not considered as a valid activity for this management plan.

Section 6
Description of Alternatives

This section describes the groundwater management alternatives developed to meet the goals of the GWMP. The alternatives evaluate water management from different conceptual viewpoints, each with the intent of achieving the goals of the GWMP in a timely, cost-effective, and environmentally responsible manner.

Four alternatives are identified to meet the current and future demands of EVWMD, while achieving a sustainable water balance in the Elsinore Basin. Due to the programmatic nature of the GWMP, the alternatives and their associated facilities and programs are conceptual and, other than those programs identified as ongoing projects, may differ in their ultimate configuration. The four different alternatives are:

- Alternative 1 – Dual Purpose Wells
- Alternative 2 – Surface Spreading
- Alternative 3 – In-lieu Recharge and Water Conservation
- Alternative 4 – Combination

The purpose of Alternatives 1, 2 and 3 is to attempt to manage the basin using different strategies to identify those strategies that perform better. Alternative 4 is developed based upon evaluation of the first three alternatives and includes a combination of the best strategies. Each alternative is compared with the baselines discussed in Section 4. For the comparison of alternatives and to evaluate the impact of the different activities on the groundwater levels in the basin, a numerical groundwater model is used to simulate the groundwater response to a repeat of the hydrologic conditions for the period 1961 through 2001. This allows evaluation of basin response over a wide range of wet, normal and dry years. The projected water demands for 2020 are met with Alternatives 1, 3, and 4 using different sources of supply. There is a 3,800 acre-ft/yr deficit under Alternative 2. A detailed summary of the components included in the two baselines and the four alternatives is presented in **Table 6-1.**

MODELING ASSUMPTIONS

Assumptions used in the groundwater modeling and hydraulic modeling of the alternatives are discussed below. The evaluation of the alternatives and the results are discussed in detail in **Section 7**.

Groundwater Model

For each alternative, separate model input files are prepared to represent the conditions of each alternative. Numerical groundwater model input consist of the following:

.

Table 6-1
Summary of Alternatives

Item	Baseline A	Baseline B	Alternative 1 Dual Purpose Wells	Alternative 2 Surface Spreading	Alternative 3 In-Lieu Recharge and Water Conservation	Alternative 4 Combination
Water Demand	Year 2000	Year 2020	Same as Baseline B	Same as Baseline B	Year 2020 with 10% water conservation	Same as Baseline B with 5% water conservation
Water Supplies	Current Supplies: • 8 Existing EVMWD Wells • 4 Existing EWD Wells • Canyon Lake WTP • AVP Connection • TVP Connection	• Same as in Baseline A • Joy Street Well • 11 wells for peaking	• Same as in Baseline A • Joy Street Well • Conversion of 4 existing wells to dual purpose wells • 10 new dual purpose wells • 4 wells for peaking	• Same as in Baseline A • Joy Street Well • 5 new extraction wells • 11 wells for peaking	• Same as in Baseline A • Joy Street Well • 8 wells for peaking	• Same as in Baseline A • Equipping Joy Street Well as dual purpose • Conversion of 6 existing wells to dual purpose wells • 7 new dual purpose wells • 4 wells for peaking
Land Use	Year 2000	Year 2020	Same as Baseline B	Same as Baseline B	Same as Baseline B	Same as Baseline B
Lake Replenishment	None	• 7.5 mgd of Recycled Water • 3 Island Wells	Same as Baseline B	Same as Baseline B	Same as Baseline B	• 17.7 mgd of Recycled Water • 1 Island Wells
Septic Tanks	Existing Septic Tanks	Existing Septic Tanks	Conversion of all Septic Tanks in at least the High-Risk Zone	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Special Projects (in addition to the peaking wells)	None	• 17.9 miles of 36-inch to 12-inch diameter pipeline to bring in new source water[2] from the Woodcrest Turnout to Lake St. Tank.	Dual Purpose Wells with imported water: • 3 deep wells north of the lake • 6 deep wells south of the lake[1] • 5 shallow wells south of the lake Other Facilities: • 30-inch diameter pipeline (4,000 ft) • 800 HP pumping station between Cal Oaks and the Back Basin	Surface Spreading with imported water: • 25-acre spreading basin in Leach Canyon • 15-acre spreading basin in McVicker Canyon • 5 extraction wells north of Lake • Pipelines and PS to convey add'l water source to spreading basins	• 8 peaking wells	Dual Purpose Wells with imported water: • 3 deep wells n/o the lake[3] • 6 deep wells s/o of the lake[1] • 5 shallow wells south of the lake Other Facilities: • 30-inch diam. pipeline (4,000 ft) • 800 HP pumping station betw. Cal Oaks and the Back Basin
Basin Monitoring	• Water Quality • Groundwater levels • Groundwater production • Lake levels • Surface flow rates • Rainfall	Same as Baseline A	• Expanded monitoring network for parameters of Baseline A and B • Subsidence	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Stakeholder Involvement	None	None	• Formation of a basin advisory committee	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Wellhead Protection	Existing EVMWD Wells	Same as Baseline A	• Expansion to all active wells in the basin	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Well Construction and Abandonment Program	None	None	• Identification of location/status of wells through a well canvass • Development of a Well Construction and Abandonment Program that includes the coordinates of these activities with Riverside County Department of Environmental Health. • Implementation of policies and regulations	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Land Development Plans	None	None	• Coordination with local and regional planning agencies	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1

1 – Four are existing wells (Cereal 1, Cereal 3, Cereal 4, and Corydon), 2 – New source water could also come from a different location, this project was chosen allocate cost for the supply shortfall, 3 – This includes Joy Street Well.

- recharge due to infiltrating precipitation.
- recharge due to infiltration from the San Jacinto River, irrigation water and septic tanks effluent.
- groundwater pumping of potable wells for potable water demand. groundwater pumping of Island wells for lake maintenance.
- direct injection recharge (Alternatives 1 and 4)
- surface spreading recharge (Alternative 2 only)

The amounts are calculated for the hydrologic period from 1961 to 2001 with six-month stress periods. The calculations are based on providing sufficient water supply to meet the year 2020 water demands, balancing the groundwater basin when possible and maintaining the water level of Lake Elsinore at 1,240 feet MSL. A summary of the model input and resulting groundwater balance is presented in **Table 6-2.**

Table 6-2
Summary of Average Groundwater Balance for 2020

	Baseline A	Baseline B	ALT1	ALT2	ALT3	ALT4
Parameter	**acre-ft/yr**	**acre-ft/yr**	**acre-ft/yr**	**acre-ft/yr**	**acre-ft/yr**	**acre-ft/yr**
INFLOWS						
Infiltration of Precipitation						
Rural Areas	1,700	1,700	1,700	1,700	1,700	1,700
Urban Areas	900	700	700	700	700	700
Recharge from Surface Water						
San Jacinto River	1,200	1,200	1,200	1,200	1,200	1,200
Lake Elsinore	0	0	0	0	0	0
Return Flows						
Septic Systems	1,000	1,000	200	200	200	200
Applied Water	700	1,100	1,100	1,100	1,100	1,100
Subsurface Inflows	0	0	0	0	0	0
Groundwater Recharge						
Injection	0	0	6,700	0	0	5,900
Spreading	0	0	0	4,800	0	0
Total Inflows	**5,500**	**5,700**	**11,600**	**9,700**	**4,900**	**10,800**
OUTFLOWS						
Groundwater Pumpage						
Potable Use	(9,900)	(11,300)	(9,400)	(11,300)	(4,100)	(7,900)
Lake Replenishment	0	(900)	(900)	(900)	(900)	0
Dual Purpose Wells	0	0	(1,300)	0	0	(2,800)
Wells for Surface Spreading	0	0	0	(1,300)	0	0
Subsurface Outflow	0	0	0	0	0	0
Total Outflows	**(9,900)**	**(12,200)**	**(11,600)**	**(13,500)**	**(5,000)**	**(10,700)**
Net Surplus/(Deficit)	**(4,400)**	**(6,500)**	**0**	**(3,800)**	**(100)**	**100**

Note: Values shown are averages over the anticipated range of demands and hydrology.

Hydraulic Model

The hydraulic model developed for the Distribution System Master Plan (MWH, 2002) is used to size pipelines and booster stations and to evaluate system pressures and reservoir response in each of the four alternatives. The maximum injection and extraction capacities as summarized in **Table 6-3.**

Table 6-3
Maximum Injection and Extraction Capacities

Well Name	Extraction Rate (gpm)	Injection Rate (gpm)
Cereal Wells 1, 3, and 4	1,750	1,400
Corydon Well	1,000	750
Olive Street Well	350	None
Palomar Well	300	None
Lincoln Well	935	750
Machado Well	1,250	750
Joy Street Well	1,000	750
Proposed deep dual purpose wells in the Back Basin (Cereal 2 and Crawford)	1,750	1,400
Proposed shallow dual purpose wells in the Back Basin	700	350
Proposed deep dual purpose wells north of Lake Elsinore	1,000	750
Proposed wells north of Lake Elsinore for Extraction of Surface Spreading in Canyons (McVicker 1 and 2, Leach 1 and 2, Terra Cotta)	600	None

For the hydraulic simulations, the following assumptions are made:

- The demands in the hydraulic model include the water demands of EVMWD only. Demands of private pumpers and EWD are not taken into consideration as they are not served from the EVMWD system.
- For the simulation of injection scenarios, the ADD of year 2020 is used, as injection will only occur during winter months.
- For the simulation of extraction scenarios, the MDD of year 2020 is used. Because extraction occurs during summer months, including the maximum day. MDD corresponds

with a peaking factor of 2.0. Some scenarios are modeled at lower demands without the additional proposed peaking wells.

- Injection and extraction do not occur at the same time.
- Injection and extraction do not necessarily occur at maximum rates.
- The maximum capacity of Canyon Lake WTP is 9.0 mgd (6,250 gpm).
- The maximum connection capacity of the AVP is 24.2 mgd (16,805 gpm). The existing pumps are capable of pumping more than the rated connection, but flows are limited to the capacity of the connection.
- The maximum capacity of the TVP is 26.5 mgd (18,403 gpm), with the proposed pump station.
- The Island wells are not included in hydraulic model runs.

A comparison of the supplies and demands for each alternative is provided in **Table 6-4**. Details of supplies and demands presented in this table are discussed under each alternative. **Table 6-5** presents a Lake Elsinore balance for each alternative.

ALTERNATIVE 1 – DUAL PURPOSE WELLS

The purpose of Alternative 1 is to achieve a balanced groundwater basin through a conjunctive use program using dual purpose injection-extraction wells. Treated water would be injected during periods when replenishment water is available. The new dual purpose wells would be used to extract stored groundwater when additional supplies are required to meet the year 2020 demands.

Water Demands

Alternative 1 includes the same water demands and land use as Baseline B.

Water Supplies

Alternative 1 requires the equipping of 14 dual purpose wells. These dual purpose wells would increase the groundwater extraction capacity for potable use from 13,350 gpm (Baseline B) to 21,300 gpm. The 14 dual purpose wells include:

- Four existing wells (Corydon, Cereal 1, Cereal 3, and Cereal 4) would be converted to dual purpose wells
- Two new deep dual purpose wells in the Back Basin area (Cereal 2 and Crawford-5)
- Five new shallow dual purpose wells in the Back Basin area (South Alluvial 1 through 5)
- Three deep dual purpose wells in the area north of Lake Elsinore (North Deep 1 through 3)

Injection would take place between October and March in years when replenishment water is available, which depends on the hydrologic conditions of the sources that contribute to MWDSC's overall supply. The dual purpose wells would be used for extraction in the summer months of dry years when the demands increase and the available imported supply from MWDSC is reduced.
To meet the MDD in year 2020, three additional wells are required to provide peaking capacity, assuming that each well has a capacity of 1,000 gpm.

Table 6-4
Projected Average Supplies and Demands for 2020

	Baseline A acre-ft/yr	Baseline B acre-ft/yr	ALT1 acre-ft/yr	ALT2 acre-ft/yr	ALT3 acre-ft/yr	ALT4 acre-ft/yr
Demands						
Potable Demands	23,400	50,500	50,500	50,500	45,500	48,000
Water Conservation	0	0	0	0	5,000	2,500
Total Demands	**23,400**	**50,500**	**50,500**	**50,500**	**50,500**	**50,500**
Supplies to Meet Demand						
Groundwater						
Existing or Planned Wells	9,900	11,300	9,400	11,300	4,100	7,900
Additional Wells	0	0	1,300	1,300	0	2,800
Imported Water						
AVP	6,600	22,600	22,600	22,300	22,600	18,100
TVP	3,900	13,600	14,200	12,600	15,800	16,200
Canyon Lake WTP	3,000	3,000	3,000	3,000	3,000	3,000
Total Supplies	**23,400**	**50,500**	**50,500**	**50,500**	**45,500**	**48,000**
Lake Replenishment						
Groundwater	0	900	900	900	900	0
Recycled Water	0	2,300	2,300	2,400	2,300	3,400
Total Lake Replenishment	**0**	**3,200**	**3,200**	**3,300**	**3,200**	**3,400**
Groundwater Recharge						
Injection Wells	0	0	6,700	0	0	5,900
Surface Spreading	0	0	0	3,800	0	0
Capture of Add'l Runoff	0	0	0	1,000	0	0
Net In-Lieu Recharge	0	0	600	0	7,200	600
Total GW Recharge	**0**	**0**	**7,300**	**4,800**	**7,200**	**6,500**
Imported Supplies						
Direct Use						
Normal Deliveries	10,500	36,200	35,900	34,900	34,500	33,700
In-lieu Deliveries [1]	0	0	900	0	3,900	1,100
Injection Wells	0	0	6,700	0	0	5,900
Surface Spreading	0	0	0	3,800	0	0
Total Imported Supplies	**10,500**	**36,200**	**43,500**	**38,700**	**38,400**	**40,200**

Note: Values shown are averages over the anticipated range of demands and hydrology.
1 In-lieu deliveries are volume of water delivered to offset groundwater pumping that remain in storage for at least one year.

Table 6-5
Summary of Projected Lake Elsinore Balance for 2020

Item	Baseline A	Baseline B	Alternative 1	Alternative 2	Alternative 3	Alternative 4
INFLOWS						
Groundwater Pumping	0	900	900	900	900	0
Precipitation on Lake	3,800	3,800	3,800	3,800	3,800	3,800
Local Runoff	1,500	1,500	1,500	1,300	1,500	1,500
San Jacinto River	13,800	13,800	13,800	13,800	13,800	13,800
Recycled Water	0	2,300	2,300	2,400	2,300	3,400
Total Inflow	**19,000**	**22,300**	**22,300**	**22,200**	**22,300**	**22,500**
OUTFLOWS						
Evaporation Losses	15,600	15,600	15,600	15,600	15,600	15,600
Spills	6,000	6,700	6,700	6,600	6,700	6,700
Total Outflow	**21,600**	**22,300**	**22,300**	**22,200**	**22,300**	**22,500**
Lake Balance	**(2,600)**	**0**	**0**	**0**	**0**	**0**

Note: Values shown are averages over the anticipated range of demands and hydrology.

The injection and extraction cycles of Alternative 1 as a function of the hydrologic conditions of 1960 through 2001 are shown in **Figure 6-1**. During the 41-year hydrologic cycle, about 274,000 acre-ft of imported water would be injected, and 54,000 acre-ft of additional water would be extracted. With these operations, the groundwater basin remains in a long-term balance.

As shown in Figure 6-1, injection would take place in 33 of the 41 years. Over the 41-year period, an average of 6,700 acre-ft/yr would be injected. Extraction would take place during 22 out of the 41 years. Dual purpose wells would be used in combination with existing wells to meet demands during these periods when surplus water is not available. In addition, because dual purpose wells would not be pumping at the same time as injection, imported water would be purchased for in-lieu recharge. With Alternative 1, pumping in the winter months is reduced an average of 1,900 acre-ft and increased an average of 1,300 acre-ft during the summer months. The net long-term in-lieu recharge is approximately 600 acre-ft/yr over the 41-year period of record. However, because an average of 900 acre-ft/yr of the in-lieu water stored remains in storage for more than one year, this amount can be purchased at the long-term storage rate. Details of the long-term storage rate program are provided in Section 7.

The water supply distribution for 2020 demands in average, wet and dry years is shown in **Figure 6-2**. As shown in this figure, extraction from dual purpose wells is only required in dry years, while the increased water production at Canyon Lake WTP plant is available to meet the

Figure 6-1
Injection and Extraction Cycles of Alternative 1

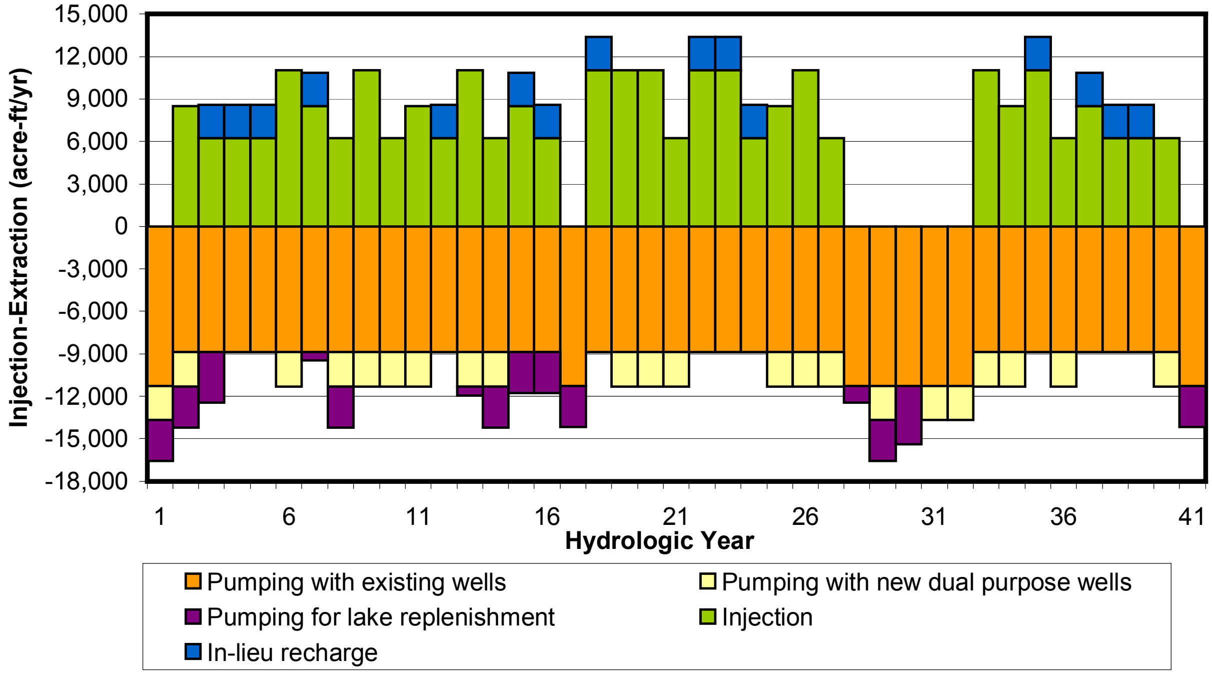
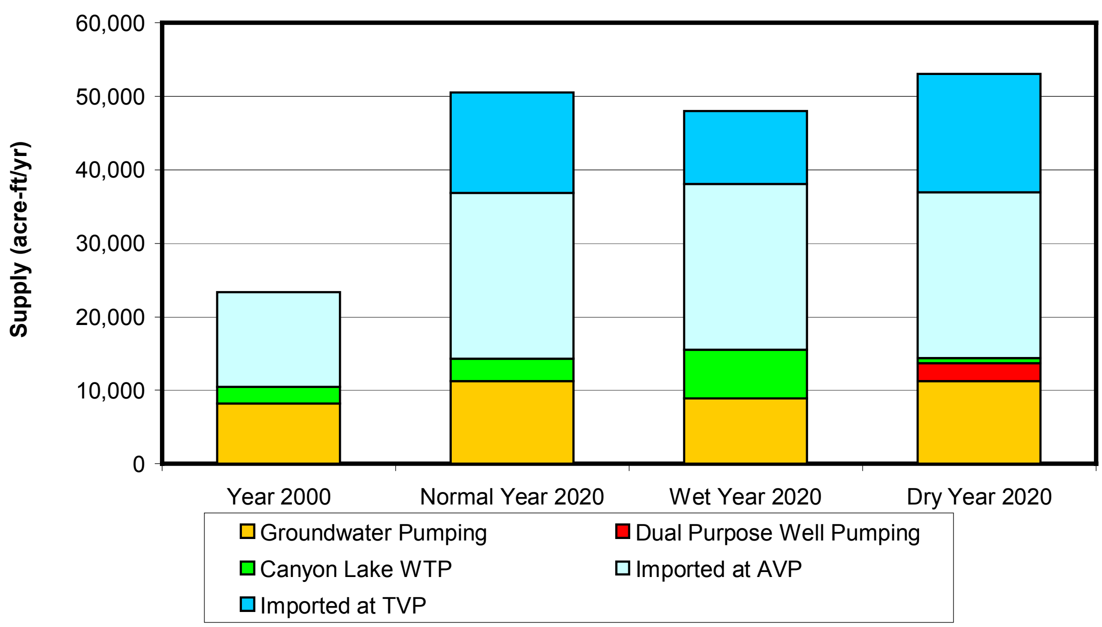


Figure 6-2
Year 2020 Potable Supplies with Alternative 1



water demands in average and wet years. On an average annual basis, about 73 percent of the demand are supplied from imported water, 21 percent from groundwater pumping and 6 percent from Canyon Lake WTP. It should be noted that these supply distributions are based on six-month average demands, and that dual purpose wells and peaking wells would need to be available to provide peaking capacity.

Analyses with a hydraulic distribution system model are performed to size any additional facilities to maintain sufficient system pressures during extraction and injection cycles. For extraction, a 30-inch diameter pipeline of about 4,000 lineal feet is required along Corydon Street from Palomar Street to Cereal Street. For injection, it is most cost-effective to build an 800 HP inline booster station near the I-15 and Clinton Keith Rd to lift the water imported from the AVP connection. For water imported through the TVP connection, it is assumed that the inline booster station at Grand Avenue can be used (reserving the direction) to lift water flowing from TVP to the Back Basin.

Septic Tanks

Alternative 1 assumes that all septic tanks in at least the high risk zone (see Section 5) would be connected to the sewer system by 2020. Approximately 2,900 septic tanks, or 80 percent of all the septic tanks in the basin, are located within the high-risk zone of the basin. The conversion of these septic tanks to the sewer system reduces the amount of infiltration from approximately 1,000 acre-ft/yr to about 200 acre-ft/yr. Although not included in this GWMP, it is recommended that all septic tanks within the Elsinore groundwater basin be converted to sewer.

Lake Replenishment

Lake replenishment activities would be the same as Baseline B.

ALTERNATIVE 2 – SURFACE SPREADING

The purpose of Alternative 2 is to achieve a long-term groundwater balance using spreading basins in the Leach and McVicker Canyons to maximize the capture of local runoff water and other available water sources. Imported water from MWDSC or recycled water from the Regional WWTP would be infiltrated in the spreading basins to supplement local runoff, in order to permit conjunctive use operation of the basin. New wells would be required in the area north of the lake to extract water that is recharged in the spreading basins. By spreading more water than is extracted, a more sustainable water balance is anticipated. For this alternative, the maximum amount of recharge at Leach and McVicker Canyon is applied assuming that the maximum size recharge facility described in **Section 5** could be constructed. Based upon recent investigations, recharge in these areas may not feasible and may limit the ability of this alternative to achieve a sustainable yield. In addition, the San Jacinto River recharge project described in Section 5 is not included because the groundwater impacts of recharge at this location are unknown given current understanding of the basin.

Water Demands

Alternative 2 includes the same water demands, land use, and lake replenishment assumptions as Baseline B, and the same septic tank assumptions as described under Alternative 1.

Water Supplies

In addition to the supplies listed in Baseline B, Alternative 2 contains five additional extraction wells to extract water that is recharged in the spreading basins. These five wells have a combined capacity of 3.5 mgd (2,400 gpm). In addition, 11 extra wells with a combined capacity of 16.5 mgd (12,000 gpm) are required to provide peaking capacity to meet the MDD in year 2020, assuming that these peaking wells have an capacity of 1,000 gpm each.

The two surface spreading grounds and the extraction wells are sized as follows:

- One surface spreading facility would be located in McVicker Canyon with 15 wetted acres and an infiltration capacity of about 1,900 acre-ft in six months.
- One surface spreading facility would be located in Leach Canyon with 25 wetted acres. This spreading basin is divided into two areas, the upper area (6 acres) and the lower area (19 acres).
- Five new extraction wells would be located north of the lake with a total extraction capacity of 2,400 gpm.

More details on the sizing of the spreading facilities are presented in **Section 5**. The ponds would be available for infiltration of imported water approximately 67 percent of dry weather days in the six-month operation period to allow for wetting and drying cycles. Volume would be reserved to provide retention of runoff. During rain events, the basins would be fully functional. The pond maintenance would occur during periods of inactivity. The spreading of local runoff can be supplemented with four different supply sources: treated imported water, untreated imported water and recycled water from the Regional WWTP or recycled water from EMWD. The required facilities are determined using the hydraulic distribution system model and are described below. The most cost-effective source will be determined in the alternative evaluation. For calculations in this report, the use of treated imported water is assumed.

Option 1 – Treated Imported Water

To deliver 11.8 mgd of treated imported water from the TVP, a 36-inch diameter pipeline of approximately 6,000 lineal feet would need to be constructed from the intersection of Lake Street and Mountain Street to the inlet locations of Leach Canyon and McVicker Park. A 30-inch diameter pipeline of approximately 7,400 lineal feet would need to be constructed from McVicker Park to the inlet location of Leach Canyon and a 24-inch diameter pipeline of approximately 5,000 lineal feet would need to be constructed from McVicker Park to the inlet location of McVicker Canyon. These inlet locations will be at the upper part of the spreading basins, where water can flow into the spreading facility by gravity. This recommendation also uses the existing 21-inch pipeline in the 1601 pressure zone along Lake Street and assumes that the Alberhill pump station as recommended in the Distribution System Master Plan is implemented (210 HP pump station from the 1434 pressure zone to the 1601 pressure zone). To pump the water from the 1601 pressure zone to the top of the spreading basins (1820 feet MSL), an 800 HP pumping station expansion at Rice Canyon Pump Station needs to be constructed. The assumptions used for the availability of treated imported water are the same as in Alternative 1.

Option 2 – Untreated Imported Water

To deliver 11.8 mgd of untreated imported water, a 36-inch diameter pipeline of approximately 48,000 lineal feet needs to be constructed from the Canyon Lake outlet at the Railroad Canyon Dam to McVicker Park. A 30-inch diameter pipeline of approximately 7,400 lineal feet would need to be constructed from McVicker Park to the inlet location of Leach Canyon and a 24-inch diameter pipeline of approximately 5,000 lineal feet would need to be constructed from McVicker Park to the inlet location of McVicker Canyon. In addition, a 2,000 HP booster station would be required to pump the water to the spreading basins, as the water level in Canyon Lake level varies between 1,372 and 1,382 feet MSL and the inlet point at both canyons is at about 1,820 feet MSL.

Option 3 – Recycled Water from the Regional WWTP

To deliver 5.9 mgd of recycled water from the Regional WWTP, a 24-inch diameter pipeline of approximately 22,000 lineal feet needs to be constructed to convey water to McVicker Park. A 20-inch diameter pipeline of approximately 7,400 lineal feet would need to be constructed from McVicker Park to the inlet location of Leach Canyon and a 16-inch diameter pipeline of approximately 5,000 lineal feet would need to be constructed from McVicker Park to the inlet location of McVicker Canyon. In addition, a 1,200 HP pumping station would need to be constructed from the plant to the inlet locations of the spreading basins, as the discharge outlet of the Regional WWTP is approximately 1,253 ft MSL and the inlet point at both canyons is about 1,820 ft MSL. It is assumed that not more that 50 percent of water infiltrated in the spreading basins can consist of recycled water in accordance with DHS regulations for recharge with recycled water. Therefore, recycled water can only be used in combination with local runoff and imported water. It should be noted that this source is only available when recycled water is not used for lake replenishment.

Option 4 – Recycled Water from EMWD

In periods when EMWD pumps recycled water to Temescal Wash for discharge, this water can be captured and pumped to the spreading basins. Assuming that up to 5.9 mgd of recycled water would be available from EMWD (likely only in wet years), a 36-inch diameter pipeline of approximately 25,000 lineal feet needs to be constructed to convey water to McVicker Park from the EMWD outlet point. A 30-inch diameter pipeline of approximately 7,400 lineal feet would need to be constructed from McVicker Park to the inlet location of Leach Canyon and a 24-inch diameter pipeline of approximately 5,000 lineal feet would need to be constructed from McVicker Park to the inlet location of McVicker Canyon. In addition, a 2,400 HP booster station would be required to pump the water to the spreading basins, as the elevation at the EMWD outlet point is 1,255 ft MSL and the inlet point at both canyons is about 1,820 feet MSL.

Cost Comparison of Various Sources

The cost of using recycled water for surface spreading versus treated and untreated imported water is estimated to determine which source is the most cost-effective. The results of this comparison are shown in **Table 6-6**, while details on the items included in each option are presented in **Appendix H**.

Table 6-6
Cost Comparison Surface Spreading Water Sources

Item	Option 1 Treated, Imported Water	Option 2 Untreated Imported Water	Option 3 Recycled Water from Reg. WWTP	Option 4 Recycled Water from EMWD
Capital Cost	$ 8,400,000	$ 28,400,000	$ 15,200,000	$ 16,400,000
Annual Capital Cost	$ 337,000	$ 1,053,000	$ 605,000	$ 641,000
Annual Power Cost	$ 232,000	$ 580,000	$ 464,000	$ 638,000
Annual Supply Cost	$ 1,260,000	$ 978,600	$ 630,000	$ 976,000
Total Annual Cost	$ 1,829,000	$ 2,611,600	$ 1,699,000	$ 2,255,500
Total Supply (acre-ft/6 months)	**4,200**	**4,200**	**2,100**	**2,100**
Unit Cost per acre-ft	**$ 435**	**$ 622**	**$ 809**	**$ 1,074**

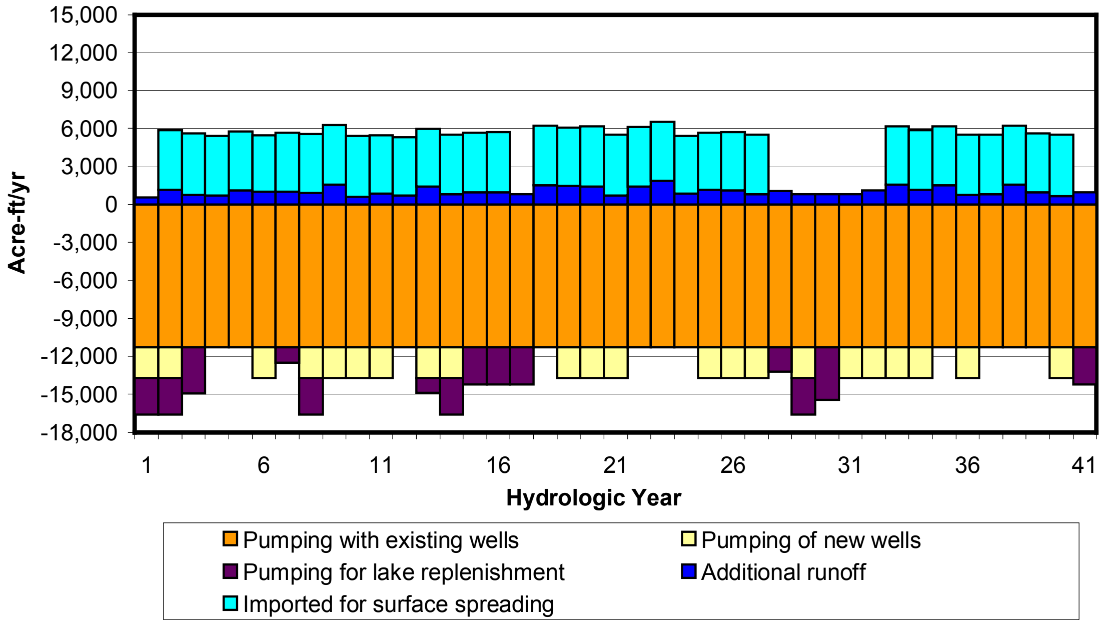
Based on the cost estimates of the four options, it can be concluded that the use of treated imported water is the least expensive, and the other three sources are about 1.5 to 2.0 times more expensive. The higher costs for the options with recycled water are caused by the draft DHS regulation that not more than 50 percent of the water spread can be recycled water. This requirement result in double infrastructure improvements to convey and pump both treated imported water and recycled water to the spreading basins. It should be noted that the cost per acre-foot is likely to be lower, when the same recycled water pipeline is used to serve irrigation demands along the route of the pipeline including McVicker Park. Although the investigation of the extend of this potential recycled water demand is beyond the scope of this project, it is not expected that this will reduce the cost of Option 3 and 4 below $435 per acre-foot. As shown in **Table 6-6**, the capital cost increases with distance. As the untreated MWDSC water is the furthest away from the spreading basin locations, high capital investments are required for a pipeline and pumping station from Canyon Lake to the spreading basin. The Regional WWTP is closer to the basins than the connection with EMWD near the sill in the Lake outlet channel, which results in slightly lower capital cost. The cost of using treated imported water is the lowest because of a combination of 1) the shorter distance to the spreading basins, 2) lower pumping cost, and 3) because the existing distribution system can partially be used to convey treated imported water. A detailed cost summary is included in **Appendix H**.

The amounts of surface spreading with local runoff and imported water/recycled supplies, and the associated extraction with the four new extraction wells to meet the year 2020 demands are shown in **Figure 6-3** as a function of the hydrologic conditions from October 1960 through September 2001. As shown in this figure, the amount of water spread would always be greater than zero, even in years that imported or recycled replenishment water is not available, as local runoff will contribute some amount of recharge.

During the 41-year hydrologic cycle, about 197,000 acre-ft of water is recharged in the spreading basins, 22 percent from local runoff and 78 percent from imported or other source water. During the 41-year period, about 42,000 acre-ft would be extracted. Replenishment would take place every year, ranging from 540 to 6,540 acre-ft in six months. Extraction would take place during

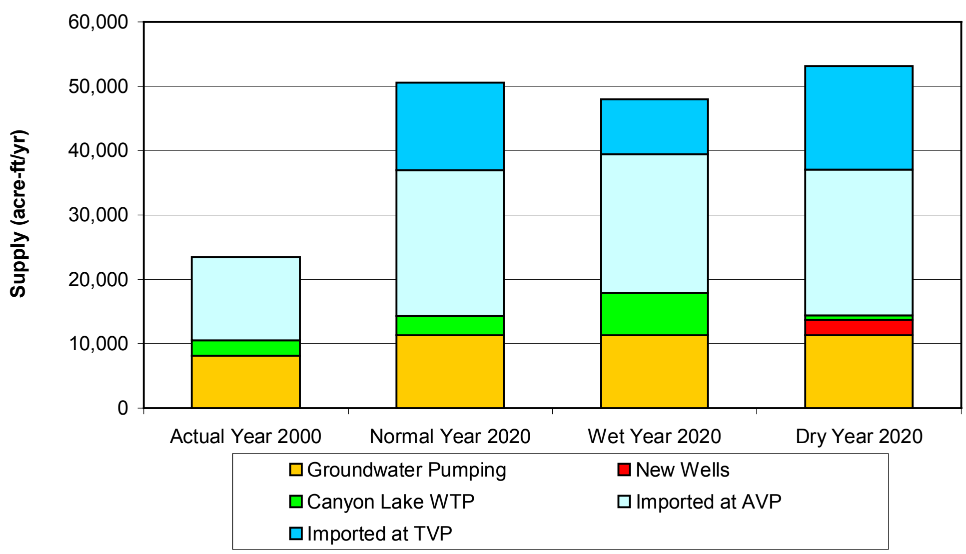
22 years of the 41-year period and ranges from 0 to 1,930 acre-ft in six months. With these operations, the groundwater basin has an average deficit of 3,800 acre-ft/yr compared to 6,400 acre-ft/yr in Baseline B. Availability of suitable land limits the surface spreading capacity, hence a sustainable groundwater balance is not achieved in this alternative. No in-lieu recharge would occur with Alternative 2 because wells would not turned off during the recharge operations.

Figure 6-3
Surface Spreading and Extraction Cycles Alternative 2



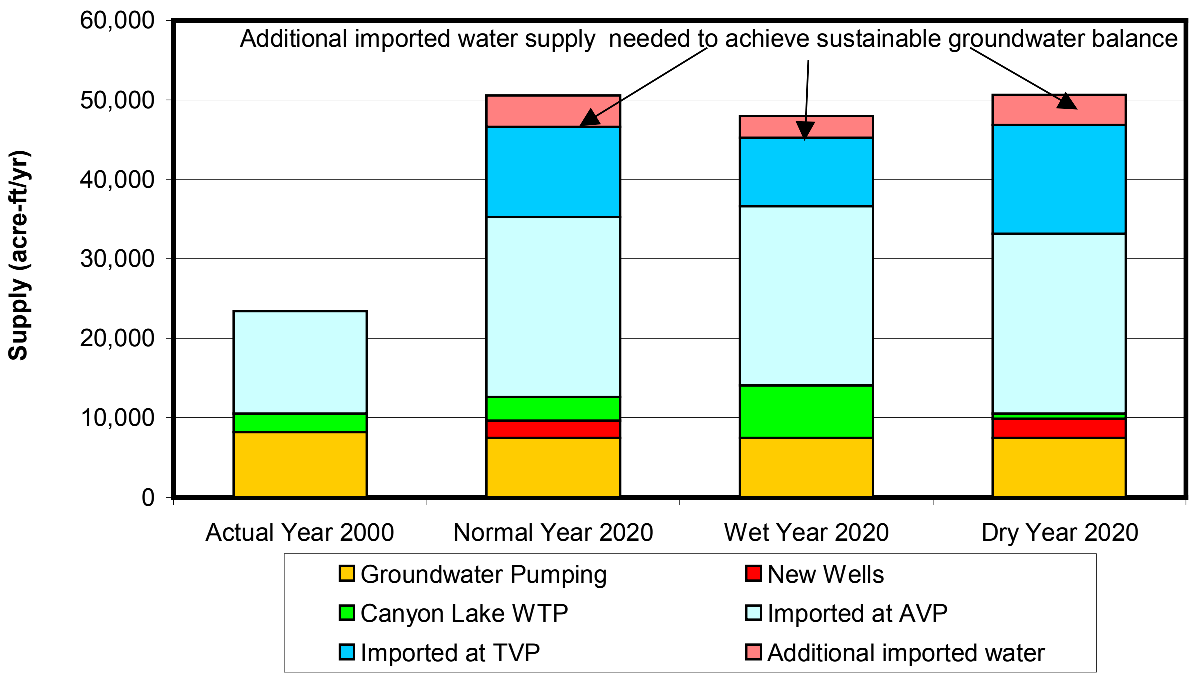
The water supply distribution for the year 2020 demands in average, wet and dry years is shown in **Figure 6-4**.

Figure 6-4
Year 2020 Potable Supplies for Alternative 2



As shown in this figure, groundwater pumping with the four new wells that extract the water recharged in the canyons is only required in dry years. It should be noted that this supply distribution does result in a groundwater deficit of approximately 3,800 acre-ft/yr as presented in **Table 6-2**. When this amount is subtracted from the groundwater pumping amounts and replaced by additional imported water supplies, a sustainable groundwater balance is achieved. This situation is presented graphically in **Figure 6-5**. It should be noted that these supply distributions are based on six-month average demands, and that peaking wells would need to be available to provide peaking capacity.

Figure 6-5
Supply Mix to Meet Year 2020 Demands
with Sustainable Groundwater Balance– Alternative 2



ALTERNATIVE 3 – IN-LIEU RECHARGE

The purpose of Alternative 3 is to achieve a long-term groundwater balance using a combination of in-lieu recharge and water conservation. With in-lieu recharge, the amount of imported water used would be maximized to reduce groundwater pumping, hence increasing the basin storage as natural inflows continue. For in-lieu recharge, construction of new facilities is not required, with the exception of the eight new wells are needed to provide peaking capacity to meet MDD in year 2020 assuming that these peaking wells have a capacity of 1,000 gpm each.

Alternative 3 includes the same water supply, land use and lake replenishment assumptions as Baseline B and the same septic tank assumptions as described under Alternative 1. Differentiating components and activities are described below.

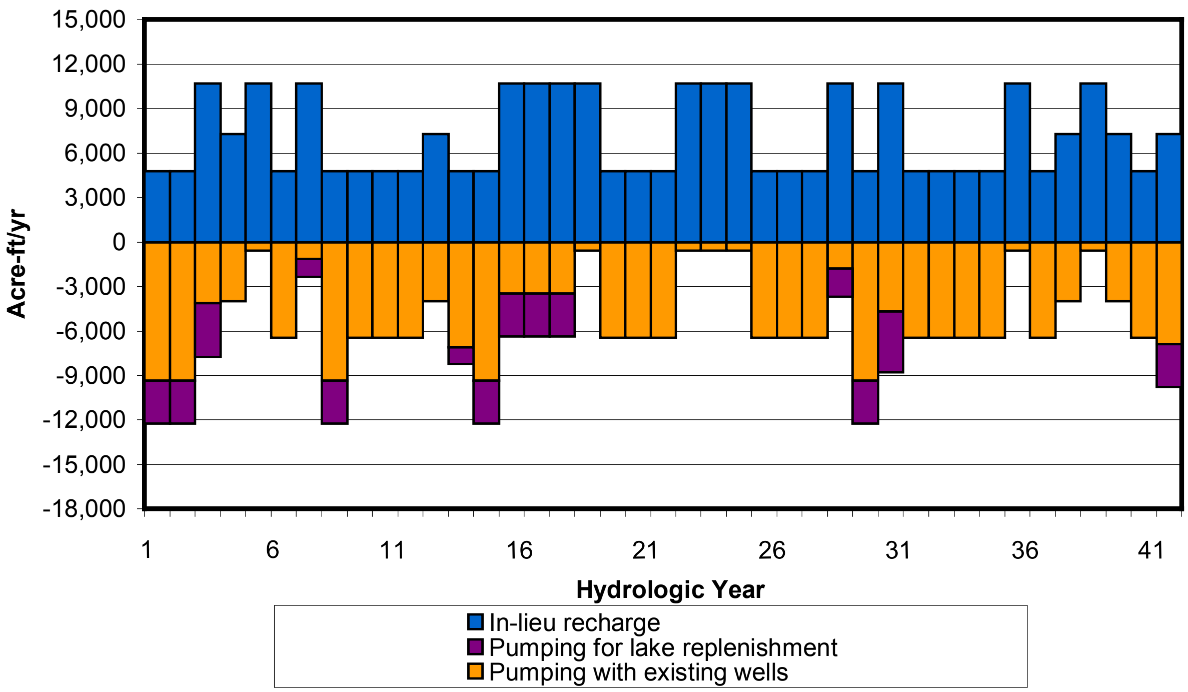
Water Demands

The water demands in Alternative 3 would be reduced as discussed in the water conservation portion of Section 5. The average annual water demand in normal demand year is assumed to decrease from 50,500 acre-ft/yr to 45,500 acre-ft/yr, a reduction of ten percent. Annual water demands are assumed to vary plus or minus five percent between hot, dry years and cool, wet years compared to normal year conditions.

Water Supply

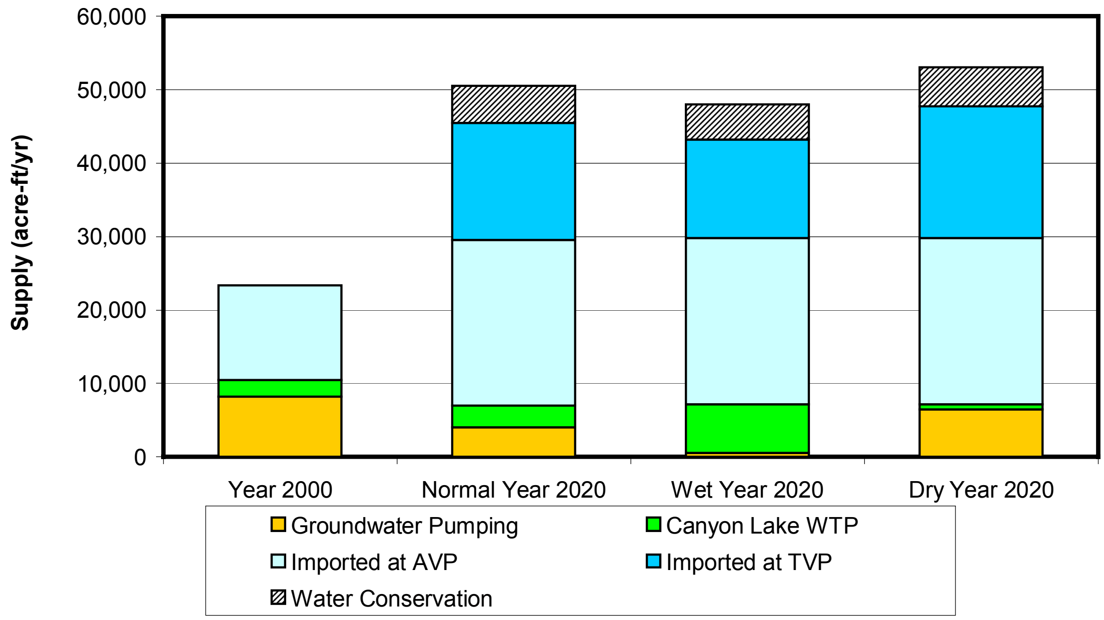
The amounts of groundwater pumping, imported water for in-lieu recharge as a function of the hydrologic conditions from October 1960 through September 2001 are shown in **Figure 6-6**. About 50 percent of the groundwater pumping of Baseline B is replaced with imported water in Alternative 3. With this alternative, pumping is reduced approximately 3,900 acre-ft during the winter months and 3,300 acre-ft during the summer months. This pumping is replaced with imported water creating in-lieu recharge. The winter recharge could be purchased at long-term storage rates.

Figure 6-6
Groundwater Pumping and In-Lieu Recharge – Alternative 3



The water supply distribution for the year 2020 demands in average, wet and dry years is shown in **Figure 6-7**.

Figure 6-7
Year 2020 Potable Supplies for Alternative 3



As shown in this figure, the groundwater pumping in wet years is almost zero and primarily offset by the increased production of Canyon Lake WTP. The reduced water demands due to conservation measures can be met with imported water when in-lieu replenishment takes place. These assumptions are based on calculations that balance the groundwater basin over the 41-year period while meeting year 2020 demands. Alternative 3 achieves a balanced groundwater basin, meaning that the amount extracted is equal to the amount replenished over the 41-year period. In this alternative, 85 percent of the average water demands are supplied from imported water, nine percent from groundwater and six percent from the Canyon Lake WTP.

It should be noted that these supply distributions are based on a six-month average demands, and that peaking wells would need to be available to provide peaking capacity.

ALTERNATIVE 4 – COMBINATION ALTERNATIVE

The purpose of Alternative 4 is to achieve a long-term groundwater balance using a combination of dual purpose wells, in-lieu recharge, and water conservation. Dual purpose wells would be installed in the Back Basin area as well as in the area north of Lake Elsinore. Similar to Alternatives 1 through 3, injection of treated imported water is only possible in periods when MWDSC makes replenishment water available.

As discussed above, spreading basins in McVicker Canyon and the upper portion of Leach Canyon may not be feasible. In addition, as is discussed in more detail in Section 7, Alternative 1 performed better than Alternative 2 in the northwest portion of the basin in terms of water level response and cost. Due to the high cost of pipelines and booster stations to convey the relatively small amount of supplemental water and the small amount of local runoff captured from these facilities, surface spreading is not included in Alternative 4.

For this alternative, construction of new dual purpose wells, pipelines and booster stations is required. Alternative 4 includes the same land use assumptions as Baseline B and the same septic tank assumptions as described under Alternative 1. Differentiating components and activities are described below.

Water Demands

The water demands in Alternative 4 would be reduced with five percent compared to ten percent in Alternative 3. It is anticipated that this degree of water conservation is feasible without many financial incentives, as the projected demands of the Distribution Master Plan did not include any water conservation while current building codes require the installation of water saving devices. The average annual water demand in a normal year would decrease from 50,500 acre-ft/yr to 48,000 acre-ft/yr. Annual water demands are assumed to increase five percent in dry years and decrease five percent in wet years compared to normal year conditions.

Water Supplies

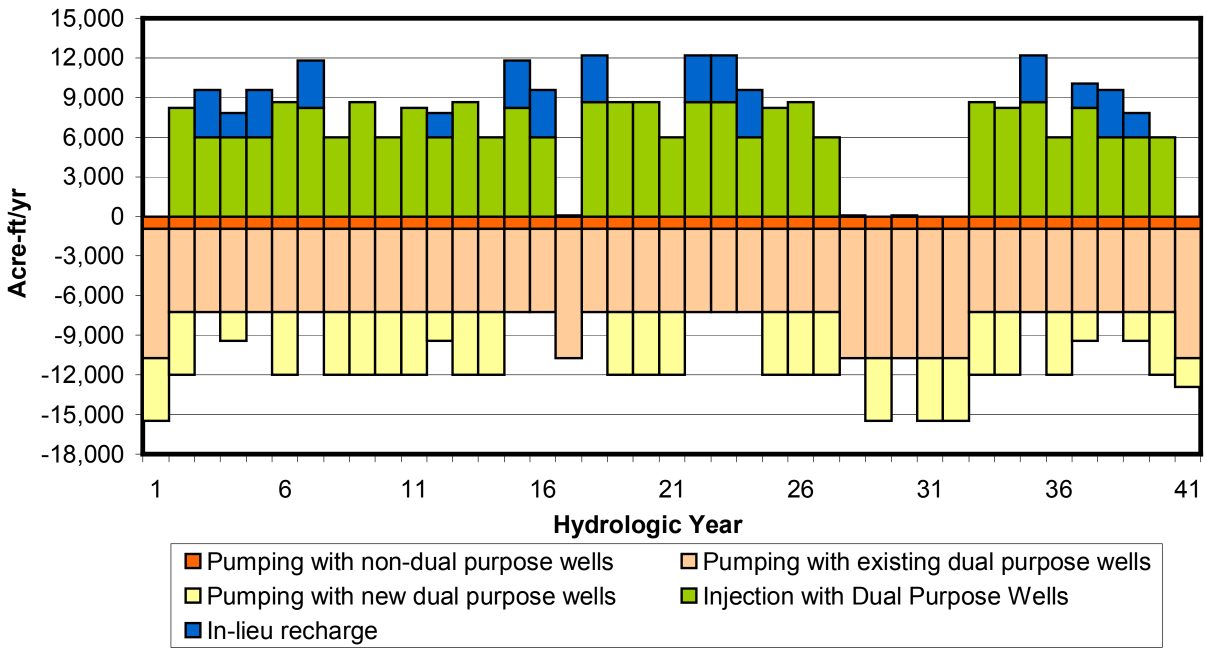
In addition to the supplies listed in Baseline B, Alternative 4 has a total of 14 dual purpose wells. Injection would take place between October and March in years when replenishment water is available, which depends on the hydrologic conditions of the sources that contribute to MWDSC's overall supply. The dual purpose wells would be used for extraction in the summer months of dry years when the demands increase and the available imported supply from MWDSC is reduced. These dual purpose wells are:

- Existing wells in the Back Basin area (Corydon, Cereal 1, Cereal 3, and Cereal 4) would be converted to dual purpose wells
- Two new deep dual purpose wells in the Back Basin area (Crawford-5 and Cereal 2)
- Five new shallow dual purpose wells in the Back Basin Area (South Alluvial 1 through 5)
- Joy Street well would be equipped as a dual purpose well
- Two new deep dual purpose wells in the area north of Lake Elsinore

In addition, four additional wells with a capacity of 1,000 gpm each are needed to provide peaking capacity to meet MDD.

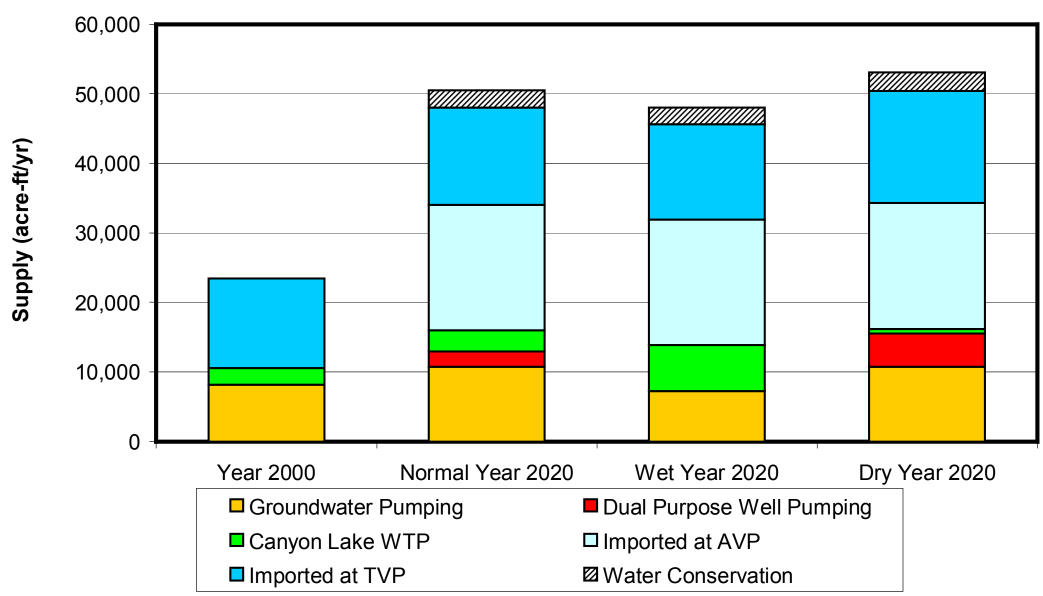
Figure 6-8 shows the injection and extraction cycles of Alternative 4 as a function of the hydrologic conditions of 1960 through 2001. During the 41-year hydrologic cycle, about 240,000 acre-ft of imported water would be injected. With these operations, the groundwater basin remains in a long-term balance, meaning that the amount extracted is equal to the amount replenished over the 41-year period. As shown in this figure, lake replenishment from groundwater (because lake replenishment is provided by recycled water as discussed below) is insignificant, hence, less injection of imported water is required to maintain a sustainable groundwater balance. As a result, potable groundwater pumping is reduced by an average of 3,100 acre-ft during the winter. Pumping is increased by about 2,500 acre-ft during the summer, which results in a net in-lieu recharge of about 600 acre-ft/yr. However, approximately 1,100 acre-ft of the in-lieu water stored during the winter months remains in storage for more than one year, which allows EVMWD to take advantage of long-term storage water rates. More details on this issue are provided in **Section 7**.

Figure 6-8
Groundwater Pumping and Injection – Alternative 4



The water supply distribution for the year 2020 demands in average, wet and dry years is shown in **Figure 6-9**.

Figure 6-9
Supply of Year 2020 Demand with Alternative 4



As shown in this figure, the dual purpose well are only required in dry years, when demands increase and the production of Canyon Lake WTP is almost zero. Alternative 4 achieves a balanced groundwater basin, In this alternative, 71 percent of the average potable water demands are supplied from imported water (not including water used for replenishment), 23 percent from groundwater and six percent from the Canyon Lake WTP. It should be noted that these supply distributions are based on a six-month average demands, and that dual purpose wells and peaking wells would need to be available to provide peaking capacity.

Lake Replenishment

Lake replenishment is assumed to be accomplished with recycled water and groundwater when the lake level drops below elevation 1,240 feet MSL. Recycled water would be used as the primary source of replenishment water up to 17.7 mgd. This is the projected capacity of the Regional WWTP in year 2020 minus 0.5 mgd for environmental discharge to Temescal Wash. One of the three Island wells would be used as the secondary source when the recycled water supply is not adequate to maintain the Lake level at elevation 1,240 MSL. Based on Lake balance calculations, replenishment with groundwater occurred twice in 41 years. In addition, recycled water from EMWD could be used if necessary.

The remaining sections of this report will evaluate the alternatives presented herein and recommend an implementation strategy for the preferred alternative.

Section 7
Evaluation of Alternatives

INTRODUCTION

The selection of a preferred alternative involves evaluating each alternative against a set of evaluation criteria and the conditions of Baseline B as discussed in **Section 4**. The alternative which best meets the evaluation criteria is selected as the preferred alternative. This section described the assumptions used in groundwater modeling, hydraulic modeling and cost calculations, followed by a discussion of the evaluation criteria, the evaluation results, and the selection of the preferred alternative.

EVALUATION CRITERIA

The process of evaluating the effectiveness of each alternative in meeting the GWMP's goal involves technical analyses coupled with professional judgment and experience. Each management alternative is evaluated using the following set of criteria:

- Ability to reduce overdraft
- Expected cost
- Environmental impacts
- Risk
- Legal and regulatory implementation
- Public acceptability
- Funding
- Reliability
- Water Quality
- Flexibility
- Ease of implementation

Alternatives are rated on a scale of 1 to 5, with 5 being excellent and 1 being very poor. In addition, each criterion has a weighting factor ranging from 1 to 3, with 3 used for the most important criteria and 1 for the least important criteria. The total ranking of the alternatives compared to Baseline B is presented with and without the weighting to illustrate the impact of the assigned weighting to the final ranking of alternatives. Where possible, quantifiable measures are defined to rate the alternatives for each of the criteria, however the majority of criteria are rated based on qualitative considerations. The basis for the numerical rating of the alternatives for each criterion is presented in **Table 7-1**. The definitions of the criteria are described in more detail below.

Table 7-1
Evaluation Criteria

Evaluation Criteria	Very Poor Score (1)	Poor Score (2)	Fair Score (3)	Good Score (4)	Excellent Score (5)
Ability to Reduce Overdraft	Steep declining water levels, Storage deficit > 4,000 AF/yr.	Declining water levels, Storage deficit 1,000-4,000 AF/yr.	Some declining water levels, Storage deficit < 1,000 AF/yr.	Stable water levels, Storage surplus 0-1,000 AF/yr.	Increasing water levels, Storage surplus > 1,000 AF/yr.
Expected Costs	>$600/AF	$501-600/AF	$401-500/AF	$300-400/AF	<$300/AF
Environmental Impacts	Significant negative environmental impact and controversy.	Negative impact that can only be partially mitigated.	Some negative impact, but can be satisfactorily mitigated.	Min. negative impact, some beneficial environmental impact.	No negative impact, beneficial environmental impact.
Risk	Not technically feasible based on current information.	High risk due to use of new technologies or technically difficult components.	Moderate risk.	Low risk due to the use of demonstrated technologies at some locations.	No risk due to use of proven technologies.
Legal and Regulatory Issues	Very significant.	Significant.	Moderate.	Minimal.	None.
Public Acceptability	Public is expected to vigorously oppose.	Public is expected to oppose to some components.	Public is not expected to oppose the alternative.	Public is expected to support most components	Public is expected to support the whole alternative
Funding	Capital cost >$40 M, uneven distribution of investment.	Capital cost $31-40 M, uneven distribution of investments.	Capital cost $21-30 M, fairly even distribution of investments.	Capital cost $10-20 M and even distribution of investments.	Capital cost < $10 M and even distribution of investments.
Reliability	Reliance on imported supply in consecutive drought years >90%	Reliance on imported supply in consecutive drought years 80-89%	Reliance on imported supply in consecutive drought years 70-79 %	Reliance on imported supply in consecutive drought years 60-69%	Reliance on imported supply in consecutive drought years <60 %
Water Quality	Significant increase in TDS concentration	Moderate increase in TDS concentration	Minor increase in TDS concentration	No increase in TDS concentration	Decrease in TDS concentration
Flexibility	Not flexible.	Some degree of flexibility.	Fairly Flexible.	Very Flexible.	Extremely Flexible.
Ease of Implementation	Very high degree of technical difficulty.	High degree of technical difficulty.	Some technical difficulties anticipated.	Minimal technical difficulties anticipated.	No technical difficulties anticipated.

Ability to Reduce Overdraft

The ability to maintain a sustainable water balance over long-term hydrologic conditions is one of the primary goals of the GWMP, hence the weighting factor of this criterion is 3. Overdraft can be quantified with the two indicators: 1) the reduction in groundwater storage when outflows exceed the inflows over a long-term period and 2) by the adverse impact associated with overdraft such as declining water levels, land subsidence and water quality degradation. An increase in groundwater storage must occur to eliminate overdraft and the associated adverse impacts. Increasing groundwater inflows, reducing groundwater outflows or a combination of both can achieve a reduction of overdraft.

As described in the **Section 5**, the storage deficit under Baseline B conditions is approximately 6,500 acre-ft/yr. This deficit results in declining water levels up to 400 feet. To achieve a balanced groundwater basin, the additional recharge and/or reduction of groundwater pumping needs to be 6,500 acre-ft/yr on a long-term average basis. Alternatives that achieve this are rated as 5, while alternatives with an average storage deficit of greater than 4,000 acre-ft/yr are rated as 1. Intermediate ratings are listed in Table 7-1.

Expected Cost

Alternatives are compared based on the unit cost of water per acre-ft, which is calculated by dividing the total annual cost by the total water supply, which is the average water demand plus water conservation amount when applicable. Because one of the GWMP goals is to provide a cost-effective water supply, the maximum weighting factor of 3 is assigned to this criterion.

The following capital costs are converted to annual cost in current dollars per alternative:

- Capital cost of new peaking wells.
- Capital cost of well rehabilitation and electrical upgrades
- Capital cost of new dual purpose wells
- Capital cost of conversions of existing wells to dual purpose.
- Capital cost of spreading basins
- Capital cost of pipelines and booster stations to convey treated imported water to dual purpose wells or spreading basins

The total annual costs used to calculate the unit cost per acre-ft include:

- Annual capital cost
- O&M cost for groundwater pumping of potable wells and island wells
- O&M cost for operating Canyon Lake WTP
- O&M of spreading ponds
- Annual cost of purchasing imported water at Tier 1, Tier 2 or replenishment rate.
- Energy cost of new booster stations included in an alternative
- Annual cost of water conservation

Alternatives with a unit cost between $401 and $500 per acre-ft are rated fair (3) because the cost of Tier 1 and Tier 2 water is within this range. Alternatives with unit cost below $300 per acre-ft are rated excellent (5), while alternatives with a unit cost of greater than $600 per acre-ft are rated very poor (1). The ranges for each rating category are presented in **Table 7-1**. The assumptions used for the development of cost estimates is discussed below.

Cost Assumptions

Capital cost assumptions are developed based on data obtained from industry manufacturers, MWH's experience on similar planning projects and data provided by the District. Pipeline costs have been calculated using recent cost data for work completed by MWH. All estimates have been adjusted to an Engineering News Record (ENR) Construction Cost Index (CCI) of 7,572 (Los Angeles, March, 2003) and are consistent with the American Association of Cost Engineers guidelines for developing reconnaissance-level estimates which should range between 50 percent above and 30 percent below actual capital expenditures. A 30 percent contingency is included in the cost estimates. The engineering, administration, and legal costs are estimated to be 25 percent of construction costs. The engineering, administration, and legal costs also include typical services such as inspection, materials testing and construction management. All costs are presented in current dollars.

The alternatives are compared based upon the total annual cost, which includes the annual capital cost and the operational and maintenance (O&M) cost. For the conversion of capital cost to annual cost a discount rate (interest minus inflation) of four percent is used based on direction from the District. Pipelines are depreciated over 40 years, electrical and mechanical equipment and pump stations over 20 years, wells over 75 years, and spreading basins over 20 years.

The energy cost of groundwater pumping is calculated per well using the modeled flow rates, the water levels calculated with the groundwater model, and a unit energy cost of $0.12 per kWh. The average pumping cost over the 41-year simulation period are determined for four categories, wells in the Back Basin area, wells in the area north of the Lake, the EWD wells, and the Island Wells. As the water levels vary between alternatives, different pumping rates are calculated for each alternative. For the total groundwater pumping cost, a surcharge of $25 per acre-ft is added to the energy cost to account for treatment and well maintenance costs. This amount was assumed based upon the difference in total pumping cost provided by the district and the calculated energy cost based on model results. The total groundwater pumping cost and the unit cost per supply source that are used in the cost calculations are summarized in **Table 7-2**. This table includes $150 per acre-foot of recycled water that is used for Lake replenishment to account for the potential lost profit. This amount is a rough estimate and is used in the cost calculations to indicate that (a portion) of the lake make-up amount can be sold to future recycled water customers if a recycled water system is developed within the District's service area.

The cost of water conservation is based on estimates prepared in the Urban Water Management Plan (MWH, 2000). This plan estimated to achieve three percent water conservation by implementing a two-phase program. The annual cost of phase 1 (years 0-3) was estimated to be $108,000 and phase two (years 7-10) was estimated to cost $127,000 per year in 2003 dollars. This equals to about $122,000 per year on an annual basis. The cost includes water surveys, residential plumbing retrofits, large scale landscaping conservation and incentives, high-efficiency appliances promotion, public information, development of a water waste prohibition program, and ultra-flow toilet rebates. The cost of water conservation used in this GWMP is based on the cost estimates prepared for the conservation program presented in the UWMP. Based on the estimates a unit water conservation cost of $260 per acre-foot is used. This unit cost includes costs for EVMWD only, and does not include the costs assigned to the naturally occurring conservation as a result of plumbing codes, cost incurred by the public, or MWDSC rebates.

Table 7-2
Summary of Water Supply Cost

Water Supply Source	Baseline B	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Groundwater Wells north of Lake Elsinore	$ 124	$ 99	$ 106	$ 83	$ 78
Groundwater Wells in the Back Basin Area	$ 139	$ 86	$ 136	$ 95	$ 84
Groundwater Wells EWD	$ 95	$ 91	$ 105	$ 83	$ 81
Island Wells	$ 154	$ 109	$ 150	$ 114	$ 93
Canyon Lake WTP	$ 230				
Treated Imported Water Tier 1	$ 418				
Treated Imported Water Tier 2	$ 499				
Replenishment Water	$ 300				
Additional Source Water	$ 499				
Untreated Imported Water[1]	$ 233				
Recycled water from EMWD	$ 165				
Lost revenue from recycled water used for Lake replenishment	$ 150				

1 – Untreated water obtained through turnout WR-18B

The cost of spreading basins is estimated based on the amount of earthwork using a unit cost of $12 per cubic yard. This includes cutting, spreading to create berms, and hauling. The earthwork amounts are based on three-dimensional modeling of the sites. These amounts and the estimated capital costs are summarized in **Appendix H**.

The cost of septic tank conversions is not included in the cost estimates presented in this report. The development of the septic tank conversion policies is on going. As part of this effort and economic analysis will be conducted that evaluates the cost of septic tank conversion and the benefits of the avoided cost of well treatment and septic tank replacement cost.

The cost of converting an existing well to dual purpose use is estimated to cost $100,000 per well which includes a small building to place equipment. This estimate is not location specific and is used for all well conversions.

Environmental Impacts

The environmental impacts included in the alternative evaluation include changes in groundwater storage, land subsidence, use of land with biological resources, and impacts on habitat, water quality degradation, and public health and safety. In addition, the best use of water resources and the level of environmental responsibility are evaluated. Because one of the GWMP goals is to provide a water supply in an environmentally responsible manner, the maximum weighting factor of 3 is assigned to this criterion. Alternatives with some adverse environmental impact, that can be satisfactorily mitigated, are rated as fair score (3). Alternatives with no adverse environmental impacts and/or beneficial environmental impacts are rated as excellent (5), while alternatives with significant adverse environmental impacts that may cause controversy are rated as very poor (1). The definitions for each rating category are presented in Table 7-1.

Risk

Risk is defined as the chance that specific investments will not produce the desired results due to use of new technologies or other risks. Other risks may include a reduction in pumping capacity of wells due to declining water levels, the availability of new water supply sources, or unknown basin characteristics. As some degree of risk is expected in new planning strategies, alternatives with a moderate risk are rated as fair (3). Alternatives that contain components that are not technically feasible based on current information are rated as very poor (1), while alternatives without any risks due to the use of proven technologies only are rated excellent (5). The definitions for each rating category are presented in Table 7-1. Because risk is not part of the GWMP goal, but does relate to the potential for losses if investments do not produce the desired results, this criterion is assigned a weighting factor of 2.

Legal and Regulatory Issues

For the rating of the alternative, the legal and regulatory issues criterion is defined as the degree of difficulty for achieving compliance with existing regulations or to obtain legal approvals to implement the alternative. Legal and regulatory constraints may include, but are not limited to, the settlement agreement with EWD (monitoring mitigation plan), agreement with the City of Lake Elsinore regarding the lake levels, NPDES permit for discharge of recycled water in Lake Elsinore, and compliance with the Basin Plan objectives.

As the implementation of new project is likely to result in some legal and/or regulatory constraints, alternatives with moderate issues are rated as fair (3). Alternatives that contain components that have very significant legal and regulatory constraints are rated as very poor (1), while alternatives without any constraints are rated excellent (5). The definitions for each rating category are presented in Table 7-1. Although legal and regulatory constraints are not part of the GWMP goal, these issues can result in fatal flaw situations. Hence, this criterion is assigned a weighting factor of 2.

Public Acceptability

The public acceptability criterion is defined as the anticipated degree of public approval or opposition to the alternative. A stakeholder process is used in the development of this GWMP to gather information from the public on their concerns about the management of the Elsinore Basin and to incorporate ideas in the management alternatives. Public acceptability is a function of the negative or positive impact that the implementation of an alternative has on the public including, but is not limited to, the financial impact, environmental impact, temporary inconveniences due to construction work, and the degree of participation in water conservation programs. If the public is not expected to oppose or support to an alternative, this alternative is rated as fair (3). Alternatives that contain components that are expected be vigorously opposed by the public are rated as very poor (1), while alternatives that are expected to be supported completely are rated excellent (5). The definitions for each rating category are presented in Table 7-1. Public acceptability is not part of GWMP goal, however, the support of the public is important for the implementation of the alternatives, hence, this criterion is assigned a weighting factor of 2.

Funding

One of the components of implementation is the acquisition of funds to construct the required wells, pipelines, pumping stations, and/or spreading basins. Not only the amount of required funds, but also the distribution of required investments over time play a role in the feasibility of an alternative. Large investments at once are less desirable than projects than can be phased and funded over a period of time. Hence, this criterion is defined as the ability to acquire the required funds and the distribution of investments over the required time frame. Funding is focussed on long-term capital investments rather than annual O&M cost which are evaluated with the expected cost criterion.

Alternatives with capital cost between $21 million and $30 million that primarily allow an even distribution of investments are rated as fair (3). Alternatives with capital cost greater than $40 million and/or uneven distribution of investment are rated as very poor (1), while alternatives with capital cost below $10 million are rated excellent (5). The definitions for each rating category are presented in Table 7-1. Although funding is not part of the GWMP goal, funding needs are directly related to cost, which is one of the primary evaluation criteria. Therefore, this criterion is assigned a weighting factor of 2.

Reliability

Because water demands are projected to double over the next twenty years, and the net groundwater pumping needs to decrease to achieve a sustainable groundwater balance, the reliance on imported water supplies will increase from 56 percent in year 2000 to about 70 to 80 percent in year 2020. Although the total amount of imported water required to meet future demand does not change between alternatives, with the exception of the amount of water conserved in alternatives 3 and 4, the reliability on imported supplies in consecutive drought years varies between alternatives. The alternatives are different in their conjunctive use operations as the capacities to recharge the groundwater basin with imported supplies vary.

For the purpose of alternative evaluation, reliability is defined as the ability to meet water demands in consecutive drought years when replenishment water is not available. One way to measure the reliability of imported supplies in drought years is to calculate the average percentage of imported water used to meet the water demands in the hydrologic drought period of 1988 through 1992 when replenishment water is not available. Alternatives that use between 70 and 79 percent imported water during these four years are rated as fair (3). Alternatives that use more than 90 percent imported water in this period are rated as very poor (1), and alternatives that use less than 60 percent imported water in this period rated excellent (5). The definitions for each rating category are presented in Table 7-1. Reliability is part of the GWMP goal and, therefore, is assigned a weighting factor of 2.

Water Quality

Water quality is defined as the degree in which the salt concentration is expected to increases or decrease under an alternative. The current average TDS concentration of the Elsinore Basin is 550 mg/L in the upper aquifer and 390 mg/L in the lower aquifer, and the proposed Basin Plan Objective is 480 mg/L. The changes in TDC concentration are evaluated over the same hydrologic 41-year period as used for the other analysis, using the average inflows and outflows as presented in **Table 6-2**. Due to the limited knowledge of the amount of water that flows between the two aquifers, all evaluations are discussed in a qualitative manner only. Alternatives that are expected to result in decreased TDS concentrations are rated as excellent (5), while alternatives are expected to result in a significant increase are rates as very poor (1). The definitions for each rating category are presented in Table 7-1. Water Quality is part of the GWMP goal and, therefore, is assigned a weighting factor of 2.

Flexibility

Flexibility is defined as the ease with which plans can be changed to address unforeseen circumstances including the ability to alter the plan to account for changes in planning assumptions regarding future demand patterns, projected resources or other uncertainties. In general, alternatives that contain a combination of strategies are more flexible than alternatives that focus on solely one approach. However, some strategies are flexible by themselves, such as the ability of spreading basins to recharge multiple water sources versus injection wells that are limited to the use of water that meets drinking water standards. Alternatives that do not contain many structural components seem more flexible to adjust to unforeseen circumstances, such as higher water demands than projected, because money is not invested yet and can be used for any project to address the unforeseen condition. However, project delays reduce the flexibility to find the best solution or to deal with unforeseen problems with project implementation as time is more limited the longer projects are postponed. Alternatives that are considered fairly flexible are rated as fair (3), alternatives that do not have any flexibility are rated as very poor (1), and that are extremely flexible are rated excellent (5). The definitions for each rating category are presented in Table 7-1. Flexibility is not part of or directly related to any components of the GWMP goal, therefore, flexibility is assigned a weighting factor of 1.

Ease of Implementation

The ease of implementation is evaluated per alternative based on the ease of technical implementation of the various alternative components. Ease of implementation includes the technical difficulties to construct facilities such as the spreading basins, as well as operational difficulties, technical limitations of water conservation devices, and the ease to achieve the desired degree of public participation in water conservation programs. Alternatives with some degree of technical difficulties are rated as fair (3), alternatives with a very high degree of technical difficulty as very poor (1), and alternatives with a no technical difficulty as excellent (5). The definitions for each rating category are presented in Table 7-1. Ease of implementation is not part of or directly related to any components of the GWMP goal and, therefore is assigned a weighting factor of 1.

EVALUATION OF ALTERNATIVES

Baseline B and the four alternatives are evaluated using the evaluation criteria and rating structure described previously. The evaluation and ratings are summarized in **Table 7-3**, while a more detailed discussion per each of the evaluation criteria is provided below.

Ability to Reduce Overdraft

The ability to reduce overdraft is evaluated using the groundwater model results. As presented in **Section 4**, the groundwater levels in Baseline B drop between 100 and 400 feet over the 41-year simulation period depending on the location in the Elsinore Basin. In general, groundwater levels decline more in the Back Basin, with Corydon Well showing the greatest water level decline, than in the area north of Lake Elsinore. The water levels predicted with the groundwater model per alternative are presented in **Appendix I**. Comparison graphs of Lincoln Street, North Island, and Corydon Well are used for the evaluation of the alternatives. These comparison graphs are presented in **Figure 7-1**, **Figure 7-2**, and **Figure 7-3**.

Figure 7-1
Water Level Comparison – Lincoln Street Well

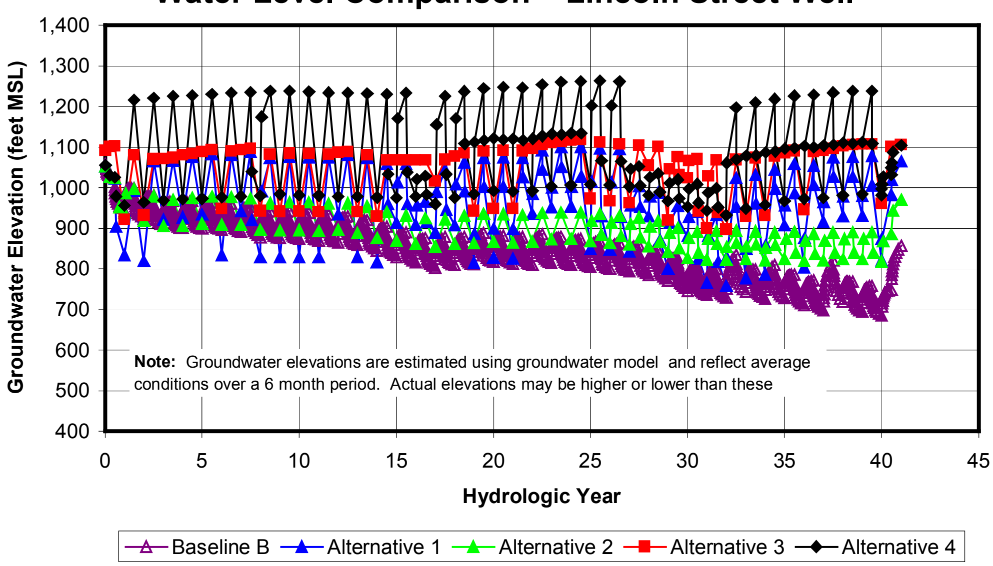


Figure 7-2
Water Level Comparison – North Island Well

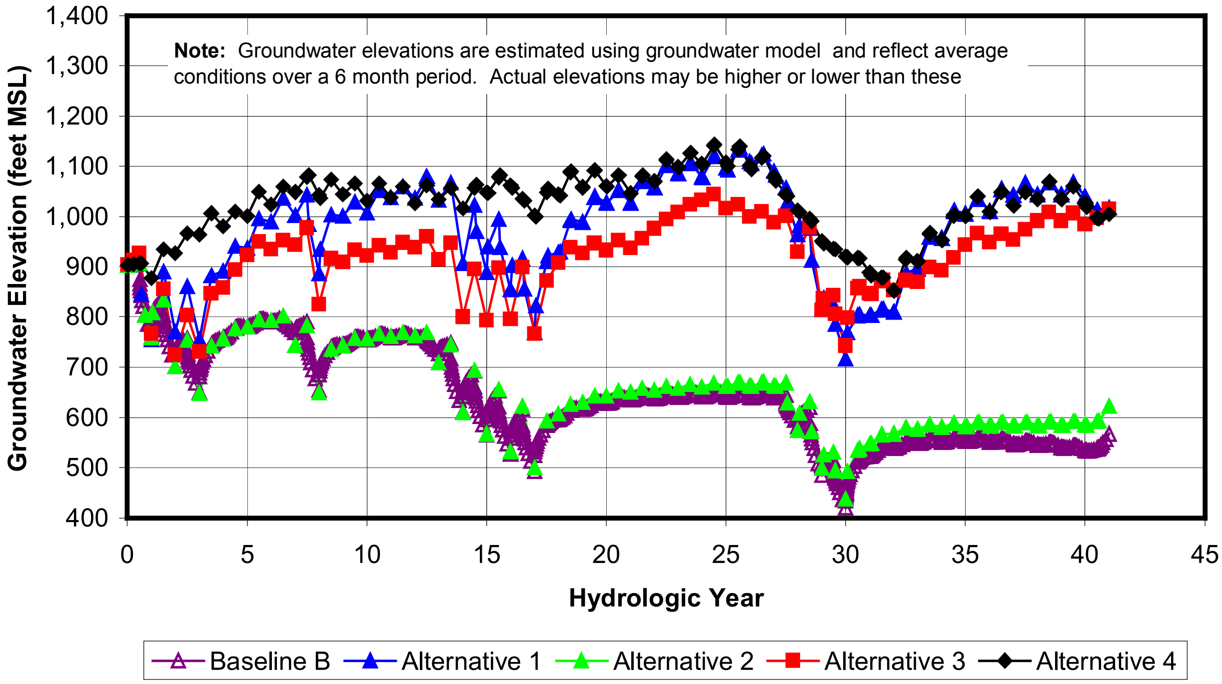


Figure 7-3
Water Level Comparison – Corydon Well

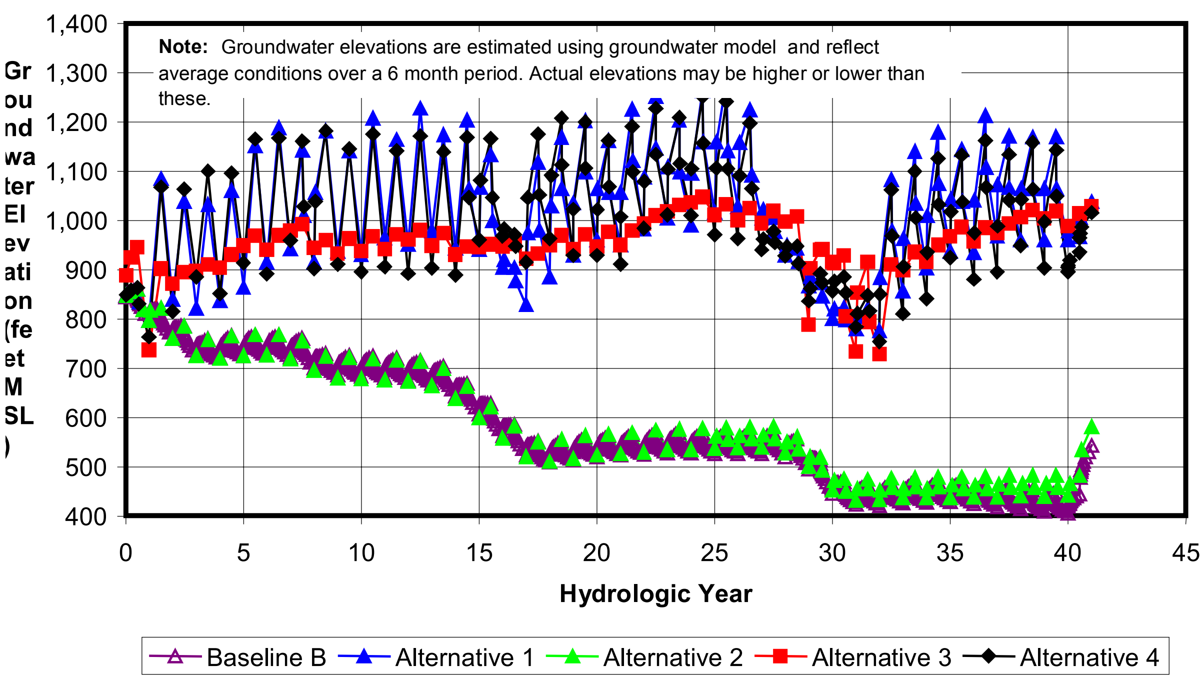


Table 7-3
Summary of Alternative Evaluation

Evaluation Criteria	Baseline B	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Ability to Reduce Overdraft	1 • Groundwater balance is not achieved. • Zero artificial recharge. • Declining water levels to 400 ft. • Storage Deficit = 6,500 acre-ft/yr.	4 • Groundwater balance is achieved. • 6,700 acre-ft/yr injected. • 600 acre-ft/yr in-lieu recharge. • Stable water levels. • Storage Deficit = 0 acre-ft/yr.	2 • Groundwater balance is not achieved. • 4,800 acre-ft/yr surface spreading. • Declining water levels to 400 ft. • Storage Deficit = 3,800 acre-ft/yr.	3 • Groundwater balance is achieved. • 7,200 acre-ft/yr in-lieu recharge. • Stable water levels. • Storage Deficit = 200 acre-ft/yr.	5 • Groundwater balance is achieved. • 5,900 acre-ft/yr injected. • 600 acre-ft/yr in-lieu recharge. • Slightly increasing water levels. • Storage Deficit = 0 acre-ft/yr.
Expected Costs	4 • $428/acre-ft • $365/acre-ft (without common cost)	3 • $446/acre-ft • $438/acre-ft (without common cost)	3 • $457/acre-ft • $480/acre-ft (without common cost)	5 • $409/acre-ft • $288/acre-ft (without common cost)	4 • $425/acre-ft • $353/acre-ft (without common cost)
Environmental Impacts	1 • Steep declining water levels cause subsidence, which can not be mitigated. • Increase energy usage due to increased pumping lift.	4 • No significant environmental impact other than the construction of wells, pipelines and a PS. • Elimination of overdraft conditions is an environmental benefit.	2 • Use of canyons for spreading basins (30 acres) is likely to cause habitat losses, which may need mitigation. • Overdraft conditions remain, this can not be mitigated.	4 • No negative environmental impact as facilities other than the constructing of peaking wells. • Elimination of overdraft conditions is an environmental benefit. • Water Conservation	5 • No significant environmental impact other than the constructing of wells, pipelines and a PS. • Elimination of overdraft conditions is an environmental benefit. • Water Conservation • Better use of water resources by eliminating groundwater use for lake replenishment
Risk	2 • High risk that wells production will decrease due to declining water levels (resulting in higher cost for additional supplies and decreased reliability). • Moderate risk that additional imported supplies may not be available.	4 • Low risk with injection/extraction technology. • Low risk that the injection capacities are lower than estimated at the time of this GWMP. • Moderate risk that additional imported supplies may not be available.	1 • High risk that surface spreading is not feasible to the extend included in this alternative due to limitations in infiltration (depth to bedrock). • Pilot testing required to determine infiltration rates. • Moderate risk that additional imported supplies may not be available.	3 • Moderate risk that 10 percent water conservation is not achieved. • Moderate risk that additional imported supplies may not be available.	4 • Low risk with injection/extraction technology. • Low risk that the injection capacities are lower than estimated at the time of this GWMP. • Moderate risk that additional imported supplies may not be available.
Legal and Regulatory Issues	2 • Declining water levels are a potential for litigation and may require adjudication of the Elsinore Basin. This causes complex legal and regulatory issues.	3 • Construction permits. • Compliance with 40 CFR Part 144, only water that meets drinking water standards can used for injection. • Development/implementation of septic tank conversion policies required. • NPDES permit required for discharge of 7.5 mgd of recycled water in Lake Elsinore. • Meet Basin Plan objectives.	3 • Construction permits. • Development/implementation of septic tank conversion policies required. • NPDES permit required for discharge of 7.5 mgd of recycled water in Lake Elsinore. • Meet Basin Plan objectives. • Use of recycled water for spreading, is limited to 50 % of the total spreading amount or RO treatment is required.	4 • Construction permits. • Development/implementation of septic tank conversion policies required. • NPDES permit required for discharge of 7.5 mgd of recycled water in Lake Elsinore.	2 • Construction permits. • Compliance with 40 CFR Part 144, only water that meets drinking water standards can used for injection. • Development/implementation of septic tank conversion policies required. • NPDES permit required for discharge of 17.7 mgd of recycled water in Lake Elsinore. • Meet Basin Plan objectives.
Public Acceptability	1 • Public is expected to vigorously oppose to unacceptable subsidence.	5 • Public is expected to support most components.	2 • The public is expected to oppose to some degree of subsidence. • The public may oppose to the construction of spreading basins in the canyons. • Public may oppose to use of recycled water for surface spreading.	3 • Public is expected to support most components of the alternative, however, 10 percent water conservation places a burden on public participation. • The alternative requires minimal construction.	4 • Public is expected to support most components.

Table 7-3 (Continued)
Summary of Alternative Evaluation

Evaluation Criteria	Baseline B	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Funding	1 • Capital Cost $56 million. • Fair distribution of investments.	3 • Capital Cost $30 million. • Uneven distribution of investments.	1 • Capital Cost $57 million. • Fair distribution of investments.	4 • Capital Cost $16 million. • Even distribution of investments.	4 • Capital Cost $24 million. • Fair distribution of investments.
Reliability	3 • 73% of water supply from MWD in consecutive drought years.	3 • 70% of water supply from MWDSC in consecutive drought years.	3 • 70% of water supply from MWDSC in consecutive drought years.	2 • 84% of water supply from MWDSC in consecutive drought years.	4 • 67% of water supply from MWDSC in consecutive drought years.
Water Quality	1 • Upper aquifer: significant increase in TDS concentration • Lower aquifer: increase in TDS concentration	3 • Upper aquifer: no change in TDS concentration • Lower aquifer: increase in TDS concentration	2 • Upper aquifer: significant increase in TDS concentration • Lower aquifer: no change in TDS concentration	3 • Upper aquifer: slight increase in TDS concentration • Lower aquifer: slight increase in TDS concentration	3 • Upper aquifer: no change in TDS concentration • Lower aquifer: increase in TDS concentration
Flexibility	2 • Projects can be implemented in the future if well production declines or subsidence occurs. However, flexibility to adjust to unforeseen circumstances is low as the need for additional supplies increases the longer projects are postponed.	5 • Dual purpose wells provide flexibility to inject/extract more water depending on demands/availability of MWDSC water. • Flexible to use multiple sources, water from Mills WTP, Skinner WTP, and Canyon Lake WTP. • Not flexible to use multiple water sources as injected water needs to comply with Title 22.	3 • Flexible to use multiple water sources for spreading; local runoff, treated imported water, untreated imported water, Canyon Lake WTP water, recycled water from the regional WWTP or EMWD. • Limited capacity of spreading basins to maximize use of replenishment water.	3 • Flexible to adjust to higher demands (lower water conservation) than anticipated with GW pumping. • Poor flexibility to implement new projects, as the need for additional supplies increases the longer projects are postponed. • Moderate flexibility to use replenishment water for in-lieu recharge as this amount is limited by (winter) water demands.	5 • Dual purpose wells provide flexibility to inject/extract more water depending on the availability of MWDSC water. • Flexible to use multiple sources, water from Mills WTP, Skinner WTP, and Canyon Lake WTP. • Not flexible to use multiple water sources as injected water needs to comply with Title 22.
Ease of Implementation	3 • Construction required of 11 wells • Substantial re-equipment of wells • Construction of new pipeline for additional source.	4 • Construction required of 13 wells, 1 pipeline and 1 pumping station.	2 • Construction of spreading basins required in canyons, which is expected to be difficult due to rocks, and difficult accessibility of the upper part of leach canyon. • Construction of 17 wells, pipelines and a booster station. • Substantial re-equipment of wells.	3 • No construction required other than 8 wells. • Implementation of water conservation measures that contribute to 10 percent conservation may be difficult.	4 • Construction required of 11 new wells • Conversion of 6 existing wells to dual purpose. • Construction of 1 pipeline and 1 PS • Implementing water conservation. measured that contribute to 5 percent conservation.
Total Rating	**21**	**41**	**25**	**37**	**45**

As shown in these graphs, the water levels in Alternative 2 are only slightly higher than the water levels in Baseline B, especially in the Back Basin area represented by Corydon Well where both scenarios drop from about 400 feet. In the area north or Lake Elsinore, represented by Lincoln Street Well, the effect of surface recharge in Alternative 2 is visible as water levels decline from 350 feet, while Baseline B about declines 450 feet. In the middle of the basin, represented by the North Island Well, the effect of surface recharge of Alternative 2 is almost diminished, as the predicted water levels are very similar, declining about 300 to 350 feet. The water levels in Alternatives 2 are clearly the worst of all four alternatives. This indicates that surface spreading alone is not sufficient to achieve a sustainable groundwater balance. If more water could be recharged in Leach and McVicker Canyons, the water levels in the area north of Lake Elsinore are likely to increase, while the levels in the Back Basin area are likely to continue to decline, due to the uneven distribution of recharge and extraction.

Alternatives 1, 3, and 4 are fairly similar with respect to water levels. The water levels of Alternatives 1 and 4 are slightly higher than the water levels in Alternative 3 in the middle and south part of the basin (indicated by the North Island Well and Corydon Well). This is caused by the positive effect of the dual purpose wells in the Back Basin area on the water levels, and it demonstrates that in-lieu recharge is not as effective in the south part of the basin as in the north part of the basin due to the lack of natural recharge. The water levels in Lincoln Street Well indicate that in-lieu recharge in the north part of the basin is more effective, as the water levels of Alternative 3 are between the water levels of Alternatives 1 (lower than Alternative 3) and Alternative 4 (higher than Alternative 3). As indicated in the three graphs, the water levels in Alternative 3 do not show the same degree of fluctuation as the alternatives with injection and extraction cycles (Alternatives 1 and 4). Water levels in Alternative 3 fluctuate about 200 to 300 feet in the north and south part of the basin respectively. Alternatives 1 and 4 show a wider range of 350-400 to 500 feet in the north and south part of the basin respectively. This indicates that the alternatives with dual purpose wells exercise the basin storage more, which is a desired situation for conjunctive use operations.

In addition to water levels, the net groundwater storage is used as a measure for the ability to reduce overdraft. As shown in **Table 7-3**, Baseline B has an average storage deficit of 6,500 acre-ft. The storage deficit of alternative 2 is reduced to 3,900 acre-ft/yr. The groundwater basin is not balanced in this alternative due to the limited infiltration capacity of the surface spreading basins, which cannot be expanded in size due to site constraints. The storage deficit in Alternative 3 is reduced to 200 acre-ft/yr, while Alternatives 1 and 4 are both balanced.

Based on the storage deficits and the degree of declining water levels, Baseline B is rated as very poor, Alternative 2 as poor, Alternative 3 with a fair and Alternative 1 as good, and Alternative 4 as excellent (increasing storage).

Expected Cost

The total capital cost and the cost per acre-ft of water are calculated per alternative with the assumptions discussed earlier in this section. A detailed cost estimate per alternative is provided in **Appendix H**, which is summarized in **Table 7-4**.

Table 7-4
Cost Summary per Alternative

Item	Baseline B	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Capital Cost	$ 49,970,000	$ 30,020,000	$ 57,380,000	$ 15,760,000	$ 24,310,000
Annual Capital Cost	$ 1,992,000	$ 1,108,000	$ 2,616,000	$ 558,000	$ 913,000
Annual O&M Cost	$ 2,645,000	$ 2,321,000	$ 2,984,000	$ 2,791,000	$ 2,970,000
Annual Imported Water Cost	$ 16,985,700	$ 19,116,000	$ 17,477,000	$ 17,307,000	$ 17,589,000
Total Annual Cost	$ 21,622,700	$ 22,545,000	$ 23,077,000	$ 20,656,000	$ 21,472,000
Supply (acre-ft/yr)	50,500	50,500	50,500	50,500	50,500
Unit Cost per acre-ft (at 3% discount rate)	**$ 428**	**$ 446**	**$ 457**	**$ 409**	**$ 425**
Unit Cost per acre-ft (at 2% discount rate)	$ 421	$ 442	$ 449	$ 407	$ 422
Unit Cost per acre-ft (at 4% discount rate)	$ 436	$ 451	$ 466	$ 412	$ 429

As shown in this table, the capital cost range significantly from $16 million to $57 million, while, the unit costs only show relatively small differences ranging from $409 to $457 per acre-ft at a three percent discount rate and including the cost and amount of imported water. The unit costs do not seem very sensitive to the discount rate used. These relatively small differences in unit cost are caused by the high contribution of purchased imported water costs, which are very similar between alternatives, ranging from $17 million to $19 million. Because the annual cost of alternative specific components is relatively small, the unit costs do not vary greatly. Although the unit costs are very similar, the effect on the groundwater basin is significant. By spending the same amount of money to meet the year 2020 water demands, more value is obtained with the alternatives that achieve a sustainable groundwater balance.

The capital cost of Baseline B is $50.0 million and includes 21 electrical well upgrades, 14 well re-equippings due to declining water levels, 11 peaking wells and the cost of bringing an additional supply source to the Districts service area. The additional supply is assumed to come from Mills WTP by constructing new pipelines ranging from 12-inch to 26-inch in diameter parallel to the TVP with a combined length of 18 miles. The total capital cost of this additional source is about $24.5 million. The annual cost of Baseline B is $21.6 million and includes the annual capital cost, energy cost of groundwater pumping of all wells, operating Canyon Lake WTP and purchase of imported water at Tier 1 and Tier 2 rates. The additional source water is assumed to cost the same as Tier 2 water. The unit cost of Baseline B is $428 per acre-ft.

The capital cost of Alternative 1 is $30.0 million and includes four well electrical upgrades, four peaking wells, four conversions of existing wells to dual purpose wells, ten new dual purpose wells, a 30-inch diameter pipeline on Corydon Street, and a 800 HP pumping station. The annual cost of Alternative 1 is $22.5 million and includes the annual capital cost, energy cost of groundwater pumping of all wells and the new 800 HP pumping station, operating Canyon Lake

WTP and purchase of imported water at Tier 1, Tier 2, and replenishment rates. The unit cost of Alternative 1 is $ 446 per acre-ft.

The capital cost of Alternative 2 is $57.4 million and includes 17 well electrical upgrades, 11 re-equipping of wells due to declining water levels, 11 peaking wells, five new extraction wells near the canyons, 30-acres of spreading ponds in Leach and McVicker Canyon, pipelines ranging from 12-inch to 36-inch in diameter and a combined length of about 4.5 miles to convey TVP water to the spreading ponds, and a 800 HP pumping station. The sizing of facilities is based on the peak capacity required, rather than the average infiltration amounts. The annual cost of Alternative 2 is $23.1 million and includes the annual capital cost, energy cost of groundwater pumping of all wells and the new 800 HP pumping station, operating Canyon Lake WTP and purchase of imported water at Tier 1, Tier 2, and replenishment rates. The unit cost of Alternative 2 is $ 457 per acre-ft. These cost estimates are based on the use of treated imported water (from TVP) as the only source for supplementing the local runoff in the spreading basins, which is determined the least expensive source based on a cost comparison of various sources discussion in **Section 6**.

The capital cost of Alternative 3 is $15.8 million and includes eight well electrical upgrades and eight peaking wells. The annual cost of Alternative 3 is $20.7 million and includes the annual capital cost, energy cost of groundwater pumping of all wells, water conservation programs, operating Canyon Lake WTP and purchase of imported water at Tier 1, Tier 2, and replenishment rates. The unit cost of Alternative 3 is $ 409 per acre-ft.

The capital cost of Alternative 4 is $24.3 million and includes four peaking wells, seven conversions of existing wells to dual purpose wells, seven new dual purpose wells, a 30-inch diameter pipeline on Corydon Street, and a 800 HP pumping station. The annual cost of Alternative 4 is $21.5 million and includes the annual capital cost, energy cost of groundwater pumping of all wells and the new 800 HP pumping station, water conservation programs, operating Canyon Lake WTP and purchase of imported water at Tier 1, Tier 2, and replenishment rates. The unit cost of Alternative 4 is $ 425 per acre-ft.

Because the cost including the purchase of water from MWDSC and the operation of Canyon Lake WTP do not show much variation between the alternatives, the cost of each alternative is also expressed without the common cost components. The amount and cost of both Tier 1 water and Canyon Lake WTP water is the same for all alternatives and Baseline B. The amounts and costs are subtracted from the unit cost presented in **Table 7-5**. In addition the amount of Tier 2 water purchased in Baseline B and the associated cost are subtracted as well. By presenting the cost without these common cost components and water supply amounts, the cost differences associated with the project are magnified. As shown in Table 7-5, the unit cost of the project related water supply varies from $288 to $438 per acre-foot. The supply amounts used for these unit costs, include groundwater pumping, in-lieu water, incremental Tier 2 purchases in comparison to Baseline B and water conservation. Alternative 3 has the lowest unit cost as it includes two cheap water supplies, in-lieu recharge and water conservation. Alternative 4 is the second cheapest with water conservation and more in-lieu recharge than Alternative 1. Alternative 2 is the most expensive alternative in both comparisons, as it does not have any cheap water sources. The alternatives are rated on the results presented in Table 7-5 as Table 7-4 does not show any variation due to the effect of common supply cost. Based on the criteria presented in Table 7-1, Alternatives 1 and 2 have a fair score (3), Baseline B and Alternative 4 a good score (4), and Alternative 3 an excellent score (5).

Table 7-5
Cost Summary per Alternative per acre-foot of overdraft reduction

Item	Baseline B	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Total Annual Cost [1]	$ 21,622,700	$ 22,545,000	$ 23,077,000	$ 20,656,000	$ 21,472,000
Common Cost – Canyon Lake WTP	$ 690,000	$ 690,000	$ 690,000	$ 690,000	$ 690,000
Common Cost - MWDSC at Tier 1	$ 5,568,000	$ 5,568,000	$ 5,568,000	$ 5,568,000	$ 5,568,000
Common Cost - MWDSC at Tier 2	$ 10,769,000	$ 10,769,000	$ 10,769,000	$ 10,769,000	$ 10,769,000
Total Common Cost	$ 17,027,000	$ 17,027,000	$ 17,027,000	$ 17,027,000	$ 17,027,000
Total Annual Cost without Common Cost	**$ 4,595,700**	**$ 5,518,000**	**$ 6,050,000**	**$ 3,629,000**	**$ 4,445,000**
Total Water Supply (acre-ft/yr)	50,500	50,500	50,500	50,500	50,500
Common Water Supply[2] (acre-ft/yr)	37,900	37,900	37,900	37,900	37,900
Project Water Supply [3] (acre-ft/yr)	**12,600**	**12,600**	**12,600**	**12,600**	**12,600**
Unit Cost ($/acre-ft)	**$ 365**	**$ 438**	**$ 480**	**$ 288**	**$ 353**

1 – See Table 7-4.
2 – Canyon Lake WTP (3,000 acre-ft/yr), Tier 1 (13,320 acre-ft/yr), and Tier 2 of Baseline B (21,580 acre-ft/yr)
3 – Total Water Supply minus Common Water Supply

Environmental Impacts

The evaluation of the environmental impacts include biological, cultural, land use, water quality, air quality, public health and safety, and other considerations. For the alternatives, the primary environmental impacts are changes in groundwater storage, potential of land subsidence, use of land that may have biological resources, impacts on habitat, water quality degradation, construction nuisances, and public health and safety. In addition, the best use of water resources and the level of environmental responsibility are included.

The primary environmental impacts of Baseline B are increased energy usage due to the increased groundwater pumping lifts and the potential of subsidence both caused by declining water levels. Geotechnical surveys need to be conducted to estimate the magnitude of subsidence. However, when 1-3 foot of subsidence per 100 feet of drawdown is used to estimate the subsidence potential for soils with interbedded clays, a 400 feet water level decline may result in subsidence ranging from 4-12 feet. Mitigation of subsidence is not possible, hence Baseline B is rated as very poor.

Alternative 1 does not have any significant environmental impact other than the construction of the groundwater wells, 3,000 lineal feet of pipeline and a pumping station. As construction nuisances are temporary and can be mitigated, these are considered as minimal negative impact. The elimination of overdraft conditions is an environmental benefit. The overall rating of Alternative 1 is good.

Alternative 2 includes the construction of 30 acres of spreading basins in McVicker and Leach Canyon as well as pipelines and a booster station to supplement runoff water with imported water. Based on the survey conducted for the Elsinore Basin Recharge Feasibility Study (MWH, 2003), no environmental impacts are identified for McVicker Canyon other than the pipeline construction. The west side of Leach Canyon is identified as a potential habitat for California gnatcatcher and Belding's orange-throated whiptail. In addition, a potentially historic farm house is identified as a cultural resource. The construction of spreading basins in Leach Canyon would also cause nuisance for the residents on the eastside of the lower spreading basins. The main environmental impact is the remaining overdraft conditions of the groundwater basin that may result in subsidence, which cannot be mitigated. The overall rating of Alternative 2 is poor.

Alternative 3 does not have any significant environmental impact other than the construction of the groundwater wells. As construction nuisances are temporary and can be mitigated, these are not considered as minimal negative impact. The elimination of overdraft conditions is an environmental benefit and ten percent water conservation is in-line with the District's mission statement to promote environmental responsibility. The overall rating of Alternative 4 is good.

Alternative 4 does not have any significant environmental impact other than the construction of the groundwater wells, 3,000 lineal feet of pipeline and a pumping station. As construction nuisances are temporary and can be mitigated, these are considered as minimal negative impact. The elimination of overdraft conditions is an environmental benefit. This Alternative has two environmental benefits. Similar to Alternative 3 this Alternative includes water conservation, which is in-line with the District's mission statement to promote environmental responsibility. Secondly, the replacement of groundwater with recycled water for lake replenishment is environmentally better as preserves more groundwater for a higher form of use, serving potable water demands. The overall rating of Alternative 1 is excellent.

Risk

Risk is defined as the chance that specific investments will not produce the desired results due to use of new technologies or other risks, such as the reduction in pumping capacity of wells due to declining water levels, the availability of new water supply sources, or unknown basin characteristics.

Baseline B has a high risk that the production capacity of groundwater wells will decrease due to declining water levels. In the water balances, the reduced in production is not included, hence the amount of water required from an additional source may be higher than calculated. Without a reduction in production capacity, the maximum amount of additional supply required is 2,440 acre-ft per six months or 4.4 mgd. Groundwater wells should provide the peaking capacity for days when the demand exceeds the average summer demand (1.25 time ADD). Decreasing groundwater production would not only increase the amount of additional supplies, but also increase the cost, and increase the reliance on imported supplies. Capital cost will increase as a larger diameter pipeline from the Woodcrest turnout or other location would be required. O&M cost may increase as well if a booster station is required to provide sufficient head for conveyance. Due to the high risk of reduced groundwater production and its undesirable consequences (higher cost and increase reliability on imported supplies), the overall rating of Baseline B is poor.

Alternative 1 includes the use of dual purpose wells from groundwater recharge. Due to the extensive experience of this technology in the United States, the use of dual purpose wells is considered a low risk. However, the injection capacities may be lower than estimated in the model simulations and balance calculation of this GWMP. If the injection capacities are found to be lower than assumed in this study, some of the proposed peaking wells could be equipped as dual purpose wells achieve the same recharge capacity. If the concept of dual purpose is incorporated in the design of new wells, no additional costs are expected. Therefore, the risk of lower injection capacities on achieving the desired injection amount is low. Based on this, the overall rating of Alternative 1 is good.

Alternative 2 has a high risk of not achieving the desired results, as a more detailed analysis of the spreading basin sites has indicated two constraints of the proposed expanded basin size options as used in Alternative 2 (see **Table 5-6** and **Table 5-7**). The first constraint is that the site slopes in McVicker Canyon limits the feasible spreading basin size to about 6 acres compared with 15 acres in the maximum basin option. The same constraint applies to Leach Canyon which spreading basin sizes are limited to 6 and 8 acres compared to 14 and 11 acres for the lower and upper part of Leach Canyon respectively. The second constraint is the limited infiltration capacity due to soil characteristics. The depth to bedrock seems to be shallower than the initial estimate, which will limit the infiltration capacity. In addition, a spillway construction is identified in McVicker Canyon, which may daylight recharge water and prevent infiltration. Additional geologic survey and pilot testing are required to determine the depth to bedrock and infiltration rates. Due to the significant reduction in potential spreading basin size (20 acres versus 30 acres), this alternative has a high risk of realizing less groundwater recharge than anticipated. The overall rating of Alternative 2 is very poor.

Alternative 3 does not contain any construction other than the construction of the peaking wells. In periods that less replenishment water is available than anticipated, sufficient groundwater pumping capacity will exist to meet the water demand from groundwater. The main risk of not achieving the proposed results is cause by the proposed water conservation rate of ten percent. This is three times higher than the amount of water conservation projected in the Urban Water Management Plan (MWH, 2000). This fairly ambitious conservation goal is considered as a moderate risk, because previous studies have not indicated a ten percent water conservation potential. Therefore, Alternative 3 is rated as fair.

Alternative 4 includes the use of dual purpose wells for groundwater recharge and five percent water conservation. The risk of dual purpose wells is discussed under Alternative 1. Five percent water conservation is considered to be achievable with existing technologies and increasing public awareness, thus and the risk of not achieving the desired degree of conservation is low. The overall rating of Alternative 4 is good.

Legal and Regulatory Issues

The degree of difficulty for compliance with existing regulations or obtaining legal approvals is evaluated for each alternative below. However some existing regulations and plans apply to Baseline B and all four alternatives. These are:

- The agreement between the District and the City of Lake Elsinore to maintain the lake levels in Lake Elsinore and in the 350-acre wetland in the Back Basin area at 1,240 feet MSL.
- The NPDES permit issued in January 2002 by the RWQCB for a pilot project to release recycled water into Lake Elsinore up to 4,480 acre-ft/yr. This permit requires that the District adhere to strict monitoring of the nutrient levels of the lake.
- The Basin Plan's water quality objectives of Lake Elsinore. These include:
  - TDS concentration not to exceed 2,000 mg/L
  - Inorganic nitrogen concentration not to exceed 1.5 mg/L
  - Dissolved oxygen concentration of 5 mg/L or above
  - Chlorine residual not to exceed 0.1 mg/L
  - Detailed regulations on fecal coliform bacteria, un-ionized ammonia and others.
- The Basin Plan's water quality objectives of the groundwater basin (see **Table 5-2**).
- Primary and secondary drinking water standards specified in the California Code or Regulations, Title 22 (see **Table 5-2**)
- The agreement between the District and EWD to participate in a Joint Groundwater Monitoring Program that specifies the monitoring requirements. The agreement established specific groundwater trigger points for Wisconsin well at 1,106 feet MSL and for Stewart well at 1,057 feet MSL to monitor groundwater level changes in the basin.
- A new NPDES permit needs to be obtained that allows discharge of 7.5 mgd of recycled water into Lake Elsinore for Baseline B and Alternatives 1, 2, and 3. Alternative 4 requires an NPDES permit with a capacity of 17.7 mgd.

Baseline B does not require compliance with any additional existing regulations or agreements, other than the permits required for the construction of the 11 new peaking wells and a new pipeline to convey additional source water to the District's service area. However, declining water levels may cause substantial subsidence, which can result in property damage and is a potential for litigation. Declining water levels results in adjudication of the Elsinore Basin, which causes complex legal and regulatory issues. In addition, the continuation of recharge from septic tanks at the existing levels potentially endangers the water quality of both the groundwater basin and Lake Elsinore. These issues are considered very significant; hence the overall rating of Baseline B is very poor.

Alternative 1 requires permits for the construction of new dual-purpose wells, peaking wells, a pipeline and a booster station are required. For the conversion of septic tanks to sewer in the high-risk zones of the basin, regulations need to be developed and implemented. The use of treated imported water for direct injection does meet the current federal requirements (40 CFR Part 144) that prohibit any injection activity that may endanger underground sources of drinking water (EPA, 1999). Dual-purpose wells are regulated under EPA's Underground Injection Control program as Class V wells. To prevent degradation of ambient ground water quality and protect the aquifer from clogging, it is recommended that water injected into aquifer recharge meet primary and secondary drinking water standards. As treated MWDSC water meets these drinking water standards, compliance with this regulation is not a legal issue. However, injection of imported water may not be in compliance with the Basin Plan objectives for TDS (currently 450 mg/L and expected to be 480 mg/L after the pending update) depending on the variation of the TDS concentration in MWDSC water. Compliance for nitrogen is not an issue, as MWDSC water does not exceed the proposed Basin Plan objective of 1 mg/L as N. Compliance is expected to be based on a 12-month running average. The overall rating of Alternative 1 is fair.

Alternative 2 requires permits for the construction of the spreading basins, new extraction wells, pipelines and a booster station. The construction of the spreading basins needs to be coordinated with RCFCWCD. During the construction of the spreading basins, dust emission need to be in compliance with current regulations, or dust control measures need to be taken. The groundwater quality is potentially impacted due to higher TDS concentrations in treated MWDSC water compared to groundwater. For the conversion of septic tanks to sewer in the high-risk zones of the basin, regulations need to be developed and implemented.

If recycled water would be used for surface spreading, compliance with DHS and the RWQCB is required. The RWQCB has a policy, Reclamation Policy – Resolution 77-1, that supports reclamation projects to assist in the increased need of water in California, primarily to support growth. The RWQCB and DHS set recycled water regulations. DHS' draft requirements for groundwater recharge by surface spreading, as of August 2002, defines the following:

- The maximum amount of recycled water that can be withdrawn at any domestic well is 50 percent
- The minimum underground retention time is six months
- The minimum horizontal distance to nearest well is 500 feet
- The minimum treatment requirements (turbidity equal or less than 2 NTUs; 5-log virus inactivation; 2.2. total coliform per 100 mL, maximum total nitrogen of 3 mg/L, TOC equal or less than 16 mg/L). In general this is tertiary wastewater treatment and disinfection. Additional treatment for removal of organics by reverse osmosis and advanced oxidation is required when projects exceed 50 percent recycled water. (Tsuchihashi et al., 2002).

As shown in **Table 6-6**, the cost of spreading recycled water is much higher than the cost of spreading treated imported water. Therefore, these legal constraints would only apply if recycled water would be used. This would also increase the cost of Alternative 2, as all cost estimates are based on the use of treated imported water for surface spreading. The overall rating of legal and regulatory issues of Alternative 2 is poor when recycled water is used and fair if treated water is used.

Alternative 3 requires permits for the construction of new peaking wells, and the development and implementation of policies that regulate the conversion of septic tanks to sewer in the high-risk zone of the basin. As the legal and regulatory issues are minimal, Alternative 3 is rated as good.

Alternative 4 requires permits for the construction of new dual-purpose wells, peaking wells, a pipeline and a booster station. For the conversion of septic tanks to sewer in the high-risk zones of the basin, regulations need to be developed and implemented. To be in compliance with the current federal requirements (40 CFR Part 144) as discussed under Alternative 1, only treated imported water can be injected. The primary legal issue is compliance with the Basin Plan objectives for TDS. The overall rating of Alternative 4 is fair.

Public Acceptability

Public acceptability is rated by the anticipated degree of public approval or opposition to the components of an alternative, including financial impact, environmental impact, temporary inconveniences due to construction work, burden on the public for the participation in water conservation programs.

It is expected that Baseline B be vigorously opposed by the residents in the areas that have a high potential for subsidence due to declining water levels. The construction of peaking wells and pipelines are not expected to cause any public concern other than construction nuisances that are addressed under the environmental impacts. However, when water levels are declining, the owners of public wells are expected to vigorously oppose, as this would result in reduced pumping capacity and/or increase energy cost for pumping. In addition, Baseline B is not the most cost-effective management option as discussed under expected cost, which is also expected to cause resistance from the public, as the goal of the GWMP is to ensure a cost-efficient water supply. With the high potential of subsidence and property damage, Baseline B is rated as very poor.

Alternative 1 is not expected to cause any public concern other than the temporary construction nuisances. It is expected that the public will fully support this alternative as it achieves a balanced groundwater basin at reasonable cost. Alternative 1 is rated as excellent.

As the risk of subsidence and property damage remains in Alternative 2, although not to the same extent as in Baseline B, it is expected that the public would oppose this alternative. Similar to Baseline B, there are no cost savings to offset this concern. On the contrary, the cost of Alternative 2 is higher than Alternatives 1, 3, and 4. In addition, the public may oppose the construction of spreading basins in the canyons as this replaces some natural habitat. If recycled water is used for surface spreading, which is not assumed in this GWMP but a possibility for future use, public opposition would be expected based on experience in other groundwater basins. The overall rating of Alternative 2 is slightly better than Baseline B due to the lower degree of subsidence, thus is rated as poor.

Public support is expected for most components of Alternative 3. However, ten- percent water conservation places an increased burden on the public that could result in opposition by a portion of the residents and businesses. This alternative does not require much construction and is the most cost-effective. The overall rating of Alternative 3 is fair.

Alternative 4 is not expected to cause many public concerns other than the temporary construction nuisances. The water conservation goal of five percent is considered feasible without placing a significant burden on the public as Alternative 3. The first five percent of water conservation is achieved with less effort than the second five percent, as all “easy” water reductions are implemented first. With increased water awareness, it is expected that the public would support the idea of water conservation as long as investments and effort required from the public are considered reasonable. Based on this, it is expected that the public will fully support this alternative as it achieves a balanced groundwater basin at reasonable cost. Alternative 4 is rated as good.

Funding

As presented under the estimated cost, the total capital cost per alternative varies from $16 million to $57 million. The ability to acquire larger amounts for funding is generally more difficult than smaller amounts, however certain investments can be funded with grants, while others would be fully funded through loans. This does impact both the total costs for the District as well as the ease of acquiring funds. In addition, the distribution of acquiring funds in included in the evaluation.

Baseline B has the second highest capital cost of $50 million. These high cost are primarily due to the cost of bringing a new source to the District's service area and the cost of peaking wells that do not serve any other purpose as in Alternative 1 and 4. Although the cost of peaking wells can be spread over time depending on the demands, the cost of the pipelines for the additional source, which contributes to 45 percent of the capital cost, is an instantaneous investment. Baseline B does not qualify for any conjunctive use grant funding or MWDSC subsidies, funding opportunities are more limited compared to Alternatives 1 through 4. Due to the high capital cost, limited funding options, and limited opportunity to spread the investment over time, the funding of Baseline B is rated as poor.

Alternative 1 has a capital cost of $30 million which is close to half the capital cost of Baseline B. About 75 percent of these cost are the dual purpose wells and the associated pipeline and booster station. This is an instantaneous investment, while the remaining 25 percent of for peaking wells, which can easily be distributed over time when demands increase. Conjunctive use projects with dual-purpose wells are likely to qualify for future grants, such as AB303 and Proposition 13. Based on the moderate capital cost, the funding opportunities and uneven distribution of investments, the overall rating of Alternative 1 is fair.

Alternative 2 has a capital cost of $57.4 million, which is highest of all alternatives. About 60 percent of this is for the construction of the spreading basins and the associated pipelines, booster station, and extraction wells. The remaining 40 percent are for the construction of peaking wells, which can be distributed over time when demands increase. Conjunctive use projects with dual-purpose wells are likely to qualify for future grants, such as AB303 and Proposition 13. Based on the evaluation criteria as presented in Table 7-1, Alternative 2 is rated as poor.

Alternative 3 has a capital cost of $15.8 million, which is least expensive of all alternatives. As the entire capital cost is for new peaking wells or adjustment to existing wells, the investment is easily distributed over time. Conjunctive use projects with in-lieu recharge are likely to qualify for future grants, such as AB303 and Proposition 13. Based on the evaluation criteria as presented in Table 7-1, Alternative 1 is rated as good.

Alternative 4 has a capital cost of $24.3 million which is less than half the capital cost of Baseline B. About 70 percent of these cost are the dual purpose wells and the associated pipeline and booster station. This is an instantaneous investment, while the remaining 30 percent of for peaking wells, which can easily be distributed over time when demands increase. Conjunctive use projects with dual-purpose wells are likely to qualify for future grants, such as AB303 and Proposition 13. Based on the relatively low capital cost, the funding opportunities and the fair distribution of investments, the overall rating of Alternative 4 is good.

Reliability

Reliability is evaluated as the ability to meet water demands in consecutive drought years when replenishment water is not available. The measure used to determine the reliability is the dependence of imported supplies during drought years. Based on the water balance calculations for the hydrologic conditions of the drought period 1988 through 1992, the amount of imported water used to meet demands is calculated. **Table 7-6** presents these results and the rating as defined in Table 7-1.

Table 7-6
Reliability of Alternatives

Supply Source	Baseline B	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Groundwater Pumping	22%	25%	25%	9%	28%
Canyon Lake WTP	5%	5%	5%	6%	6%
Total Imported	73%	70%	70%	85%	67%
Total Supply / Demand	100%	100%	100%	100%	100%
Rating	**fair**	**fair**	**fair**	**poor**	**good**

Water Quality

The water quality of Baseline B and the four alternatives is evaluated based on the overall increase or decrease of TDS concentration in the upper and lower aquifer. TDS concentrations are estimated with a preliminary mass balance calculation over the 41-year hydrologic period. Due to limited information on the flows between the two aquifers it is not possible to accurately estimate the TDS concentrations per aquifer, however a qualitative description can be made. It is recommended that water quality modeling of the groundwater basin be conducted to estimate the water quality impacts of the preferred alternative in the future.

The current TDS concentrations in the upper and lower aquifer are 550 mg/L and 390 mg/L, respectively. The upper aquifer has an estimated storage volume of 0.3 million acre-feet, while the lower aquifer has a storage volume of about 1.2 million acre-feet.

It is anticipated that the TDS concentration in the upper aquifer will increase significantly under Baseline B conditions as the infiltration from septic tanks and irrigation continuous, while the storage volume in the upper aquifer will decrease significantly as the water levels drop below the aquitard. The storage reductions will primarily impact the upper aquifer. The total storage reduction under Baseline B conditions is about 0.26 million acre-feet in 41 years, compared to a total storage volume of about 0.30 million acre-feet in the upper aquifer. As a portion of the storage reduction will impact the lower aquifer, the TDS concentration is expected to increase in the lower aquifer as well, although not as much as in the upper aquifer.

Alternatives 1 and 4 are fairly similar with respect to water quality. The upper aquifer will remain fairly constant as the addition of salt from septic tanks is reduced and the storage amount does not change. However, the TDS concentration in the lower aquifer (current TDS is 390 mg/L) is expected to increase due to the injection of higher TDS water (about 440-460 mg/L).

The TDS concentration in the upper aquifer in Alternative 2 is expected to increase significantly due to the reduced storage volume, but not as much as Baseline B as the inflow from septic tanks are reduced. The water quality of the lower aquifer will slightly improve as the water used for surface spreading (combination of runoff and TVP water) has a lower TDS concentration (about 270 mg/L) than the existing lower aquifer water (390 mg/L). However, the overall impact on the lower aquifer is expected to remain constant, as some of the salt increase in the upper aquifer will impact the lower aquifer

The TDS concentrations in both the upper and the lower aquifers are expected to increase slightly under Alternative 3 as the storage volume remains constants, the inflows from irrigation remain the same, but the outflow of salt due to groundwater pumping are significantly reduced under in-lieu operations. It is expected that TDS changes are fairly small as the effect of reduced groundwater pumping be partially offset by the decrease infiltration from septic tanks.

The expected trends in TDS concentrations for Baseline B and the alternatives are summarized in **Table 7-7**.

Table 7-7
Water Quality Summary

Supply Source	Baseline B	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Upper Aquifer					
Current TDS Concentration (mg/L)	550	550	550	550	550
Expected Trend	significant increase	constant	significant increase	slight increase	constant
Lower Aquifer					
Current TDS Concentration (mg/L)	390	390	390	390	390
Expected Trend	increase	increase	constant	slight increase	increase
Rating	**very poor**	**fair**	**poor**	**fair**	**fair**

Flexibility

Baseline B offers the flexibility to implement projects in the future if well production declines or subsidence occurs. As these projects are not part of Baseline B, the overall cost of this option would increase. Flexibility to adjust to unforeseen circumstances is low as the need for additional supplies increases the longer projects are postponed. If projects do not achieve the desired results, there is less time to test and implement new projects or make adjustments compared to alternatives that implement groundwater management projects early on. In addition, the cost of deferring groundwater management projects can be significant for the following reasons:

- The investment in an additional imported water source could be deferred, which translates into cost savings, if groundwater management projects are implemented to address the declining water levels.
- The cost of groundwater management projects will increase the longer projects are postponed as the groundwater deficit increases and larger capacity recharge facilities are required.
- Declining water levels will steadily increase groundwater pumping costs

In addition, to the limited time make adjustments and the increased cost of deferring groundwater management projects, Baseline B is not flexible manage the groundwater basin. Recharge other than in-lieu is not possible under Baseline B, thus the flexibility to recover the basin after unforeseen additional groundwater pumping, such as higher demands or lower availability of imported supplies, is very limited. Overall, the flexibility of Baseline B is poor.

Alternative 1 offers the flexibility to adjust to higher demands with additional groundwater pumping while managing the basin, as the dual purpose wells have the ability to inject more water depending on the availability of replenishment water. The use of dual-purpose wells for recharge limits the number of sources that can be used, as injection water needs to meet drinking water regulations. However, the District has access to three sources of imported water that can be used for injection, water from Mills WTP, Skinner WTP, and Canyon Lake WTP when untreated water is purchased through the WR-18B turnout. It should be noted that the use of untreated MWDSC water may not comply with the Basin Plan objectives. The basin balance calculations demonstrate that Alternative 1 is capable of recovering groundwater levels after a drought period. Thus it is flexible to adjust to various hydrologic conditions. The flexibility of Alternative 1 is rated as excellent.

Alternative 2 has the flexibility to use multiple water sources for surface spreading; local runoff, treated imported water from TVP and AVP, untreated imported water, Canyon Lake WTP water, and recycled water from Regional WWTP or EMWD. However, the recharge capacity of the spreading basin is limited and not sufficient manage the basin without other measures. Due to the limited recharge capacity, Alternative 2 does not have the flexibility to maximize the use of replenishment water when available. The flexibility of Alternative 2 is rated as fair.

Alternative 3 is flexible to adjust to higher demands with additional groundwater pumping or purchasing more imported water if ten percent water conservation is not achieved. However, as the need for additional supplies increases over time, there is less time to test and implement new projects to meet demands. This alternative has moderate flexibility to use replenishment water for in-lieu recharge as this amount is limited by the water demands in winter period. Overall, the flexibility of Alternative 3 is rated as fair.

Alternative 4 has the same flexibility characteristics as Alternative 1 with regards to dual-purpose wells and in-lieu recharge. It uses more recycled water for lake replenishment, which make the basin more flexible to store water during droughts. The flexibility of Alternative 4 is rated as excellent.

Ease of Implementation

The last evaluation criterion is the ease of implementation, which is defined as the degree of technical difficulty of the construction phase as well as operational constraints.

Baseline B does not require the use of any new technologies, and the construction of 11 peaking wells and pipeline for new source water is considered fairly easy to implement. Due to declining water levels of up to 400 feet, substantial re-equipment of wells is required to lower the pumps and add additional pump stages. Some technical difficulty is anticipated with the re-equipment of wells, especially if the well depth or casing diameter limits the ability to install new pumps. Overall, the ease of implementing Baseline B is rated as fair.

Alternative 1 requires the construction of 14 new wells, the conversion of four existing wells to dual-purpose wells, a pipeline and a booster station. Minimal technical difficulties are anticipated with the implementation of Alternative 1. Hence, this alternative is rated as good.

Alternative 2 requires the construction 16 wells and substantial re-equipment of existing wells to lower the pumps and add additional pump stages. The construction of the spreading basins is expected to be difficult due to site conditions and the difficult accessibility of the upper part of Leach Canyon. In addition, the upper part of Leach Canyon contains many native trees that must be removed causing environmental damage, and pipelines are required that bring water to the top of the canyons. Overall the construction of the spreading basins is expected to be difficult. The ease of implementing Alternative 2 is rated as poor.

Alternative 3 does not require substantial construction other than the eight peaking wells. However, implementation of water conservation measures that contribute to 10 percent conservation may be difficult as participation and investments of the public are required. The overall rating of Alternative 3 is fair.

Alternative 4 requires the construction of 11 new wells, the conversion of six existing wells to dual-purpose wells, a pipeline and a booster station. As described under public acceptability, implementation of water conservation measures that contribute to 5 percent water conservation is not anticipated to be difficult. Overall, minimal technical difficulties with the implementation are expected. Hence, this alternative is rated as good.

Selection of Preferred Alternative

The preferred alternative is selected based upon the evaluation criteria and consideration discussed in the previous paragraphs. **Table 7-8** provides a summary of the comparison and ranking of each alternative. The evaluation results indicate that Alternative 4 would best meet the evaluation criteria and with that, the objectives of the GWMP.

Table 7-8
Summary of Alternative Rating

Evaluation Criteria	Weighting Factor	Rating[1]				
		Baseline B	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Ability to Reduce Overdraft	3	1	4	2	3	5
Expected Costs	3	4	3	3	5	4
Environmental Impacts	3	1	4	2	4	5
Risk	2	2	4	1	3	4
Legal and Regulatory Issues	2	2	3	3	4	3
Public Acceptability	2	1	5	2	3	4
Funding	2	1	3	2	4	4
Reliability	2	3	3	3	2	4
Water Quality	1	1	3	2	3	3
Flexibility	1	2	5	3	3	5
Ease of Implementation	1	3	4	2	3	4
Total Rating		**21**	**41**	**25**	**37**	**45**
Weighted Rating		**42**	**81**	**50**	**77**	**92**

1 – A rating of 1 is the lowest, and a rating of 5 is the highest.

The overall ranking of the four alternatives is presented in **Table 7-9**. This table shows that Alternative 4 scores the highest of all alternatives with and without the use of weighting factors. The ranking order in which the alternatives score are the same with and without weighting factors for all alternatives, which indicates that the outcome of the evaluation is not sensitive to the weighting factor assignment.

Table 7-9
Summary of Alternative Ranking

Ranking	Ranking[1]				
	Baseline B	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Total Score without weighting	21	41	25	37	45
Ranking without weighting	**5**	**2**	**4**	**3**	**1**
Total Score with weighting	42	81	50	77	92
Ranking with weighting	**5**	**2**	**4**	**3**	**1**

1 – A ranking of 1 is the highest, and a ranking of 5 is the lowest.

The second best alternative is Alternative 1, while Alternative 3 is the third best alternative. Alternatives 1, 3, and 4 have fairly similar scores. Alternative 2 does not score much higher than Baseline B and has about 55 to 60 percent of the score of the Alternative 4. Alternative 4 is selected as the preferred alternative because it has the highest overall rating and because the District and stakeholders have indicated that water conservation should be part of the final plan.

The implementation strategy of the preferred alternative, Alternative 4, is referred to as the recommended plan and is described in **Section 8**.

Section 8
Implementation Plan

INTRODUCTION

Implementation of the Elsinore Basin GWMP will require numerous decisions regarding the priorities for implementation, the financing mechanisms for various elements of the plan, potential cooperative agreements with other agencies, and balancing water needs with available resources. This section discusses the recommendations for managing EVMWD's groundwater resources, and the financial and implementation strategies needed to actualize the proposed activities.

COMPONENTS OF THE RECOMMENDED PLAN

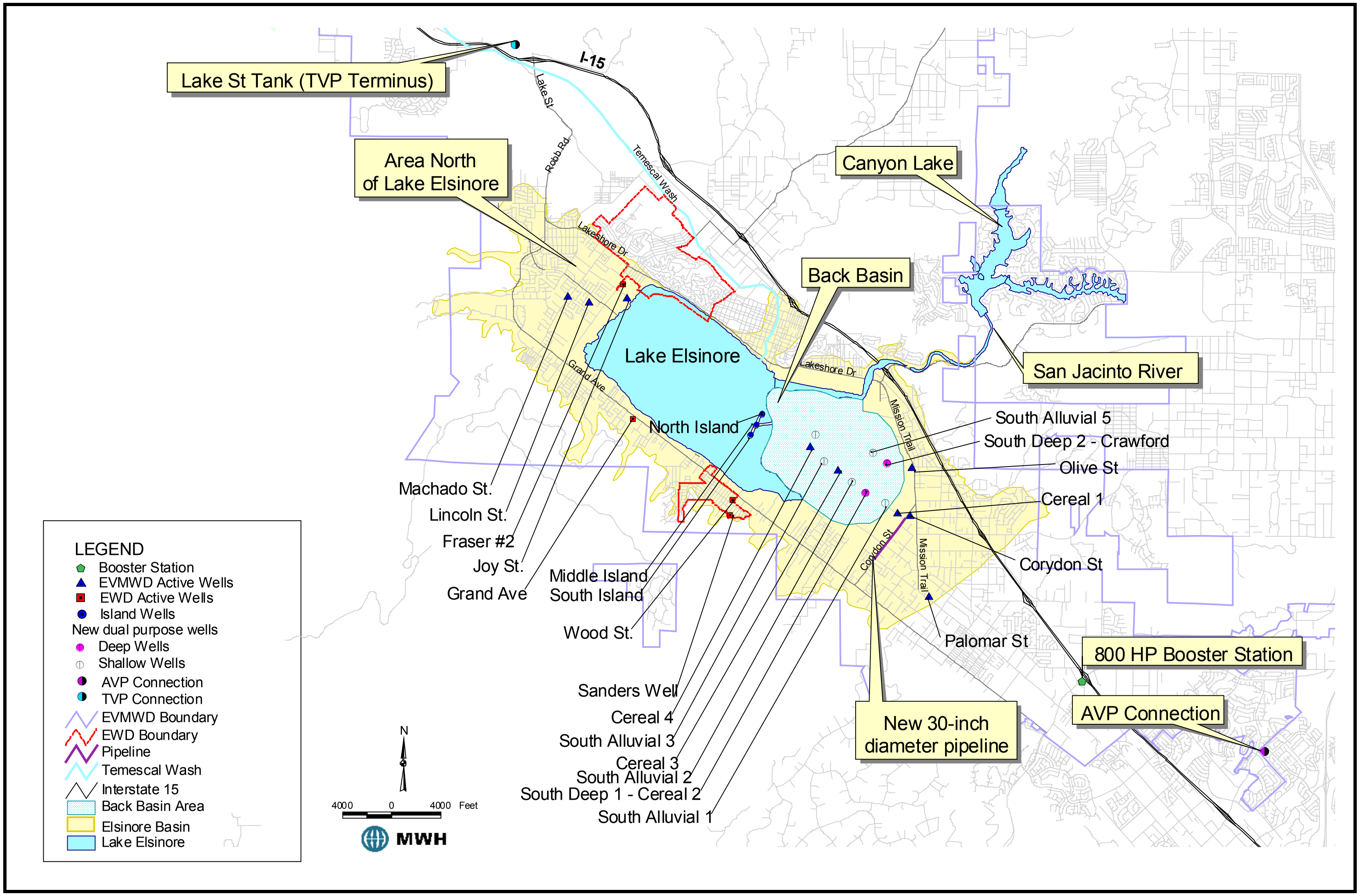
The recommended plan includes water conservation, dual-purpose wells for basin recharge, the use of recycled water as the primary source for lake replenishment, and a basin monitoring program. In addition, the plan contains recommendations for stakeholder involvement through an advisory committee, wellhead protection, well construction and abandonment procedures, the development of septic tank policies, and agency coordination. Each of these components is discussed below. A map depicting the location of the structural components required for the implementation of the recommended plan is presented in **Figure 8-1**.

Water Conservation

The prudent use of water is the focus of many utilities, regulatory agencies and the public throughout the nation. Population growth, environmental concerns, periodic droughts and the economics of new water supply development demonstrate the need to make efficient use of the available water supplies. Water conservation is described as any beneficial reduction in water use or reduction in water losses. Conservation measures can be applied to all water uses; however, in the service areas of EVMWD and EWD, the primary focus of water conservation is on municipal uses including irrigation. The minimum water conservation goals for the recommended plan is 5 percent. Water conservation measures that are part of the recommended plan are:

- Residential plumbing retrofits
- Water system audits, leak detection and repair
- Financial incentives for large landscape irrigation
- Promotion of low water use landscaping
- Promotion of high-efficiency appliances
- ULF toilet replacement program
- Public information to increase water awareness

Figure 8-1
Components of the Recommended plan



- Use of recycled water for landscape irrigation and other non-potable uses.
- School education programs.
- Water use audits for commercial, industrial, and institutional users.
- Implementation of commercial, industrial, and institutional water conservation programs.
- Assignment of water conservation coordinator.
- Development and enforcement of water waste prohibition.
- Water audits programs for residential customers.

These measures are estimated to reduce the total projected water demand for year 2020 from 50,500 to 48,000 acre-ft/yr. This level of water conservation must be achieved to ensure the additional water supplies will not be required.

Per State law, the District has completed and adopted an urban water management plan (UWMP) in 2000 which is required to be updated every five years according to the California Water Code, Sections 10610-10656. This UWMP includes most of the water conservation measures listed above and estimated that these will achieve about 3 percent water conservation due to implementation of BMPs. Additional measures such as the promotion of low water landscaping or higher participation rates in municipal programs are required to achieve the water conservation goal of 5 percent.

State law establishes a number of policies regarding water conservation and the use of recycled water and it mandates water conservation techniques, which have been already implemented in the District. Examples of these policies are:

- California plumbing codes have required the installation of ULF toilets and low-flow showerheads on all new construction since 1992.
- The *Water Conservation in Landscaping Act* (California Government Code, Sections 65591-65600) required each city and county to adopt a water efficiency ordinance for landscaping.
- The *Water Recycling in Landscaping Act* (California Government Code, Sections 65601-65607) require recycled water producers to notify local agencies of the availability of recycled water and requires local agencies to adopt and enforce a recycled water ordinance within 180 days of being notified.

The District has not developed a *Memorandum of Understanding Regarding Urban Water Conservation* (MOU), that commits participating water agencies to make a "good faith effort" to develop comprehensive conservation Best Management Practices (BMPs) programs using sound economic criteria. However, this GWMP does consider water conservation on an equal basis with other water management options and is one of the key components of the recommended plan.

Water conservation may be expanded for large scale irrigation users such as schools and golf courses by increasing the use of recycled water for irrigation. There are three principal sources of recycled water, the Regional WWTP and the regional water reclamation facilities of EMWD and Rancho California Water District (RCWD) that will discharge their effluent in the near future through a new pipeline from EMWD. The potential users of recycled water will be identified in an upcoming study, the Wildomar Recycled Water Master Plan. To determine the full potential and economic feasibility of an expanded recycled water network, the 1992 non-potable water master plan should be updated with a separate study that covers the entire service area of EVWMD and EWD. The recommended plan does not include the expansion of the recycled water network as part of the water conservation measures. This could be included in the future updates of the GWMP.

Groundwater Recharge with Dual Purpose Wells

Groundwater recharge is a critical tool for modern water management. In the recommended plan, groundwater recharge involves the injection of treated imported water into the groundwater aquifer through dual-purpose wells that can both extract and inject water. Dual-purpose wells would be installed in the Back Basin area as well as in the area north of Lake Elsinore (see Figure 8-1). The dual-purpose wells are distributed over the entire groundwater basin to allow management of groundwater levels throughout the basin. Concentrating all dual-purpose wells in one area would also require more capital investments for booster stations and/or pipelines to convey water from the imported water connections to the injection locations. It would also limit the ability to manage water levels effectively and increase well interference. The recommended plan includes the 14 dual-purpose wells as listed in **Table 8-1**

Table 8-1
Summary of Dual Purpose Wells

Area	Quantity	Description	Extraction Capacity (gpm)	Injection Capacity (gpm)
Back Basin Area	3	Cereal 1, 3, and 4 (conversion to dual p.)	1,750	1,400
	1	Corydon (conversion to dual p.)	1,000	750
	2	Crawford and Cereal 2 (new)	1,750	1,400
	5	South Alluvial 1 through 5 (new)	700	350
Area North of Lake Elsinore	1	Joy Street (equipped as dual p.)	1,000	750
	2	Deep Dual-Purpose Wells (new)	1,000	750
Total	**14**		**7,200**	**5,400**

Other Facilities

In addition to the dual-purpose wells listed in **Table 8-1**, the recommended plan requires the construction of the following facilities and pipelines. The locations of these facilities are indicated in Figure 8-1.

- Four additional wells are required for peaking to meet MDD. These wells should have an extraction capacity of at least 1,000 gpm each, otherwise more peaking wells are required.
- An in-line booster station of 800 HP (15,000 gpm at 100 feet of TDH) to increase the head in the Loop Zone when AVP water is required for injection in the Back Basin. This booster station is currently proposed near the intersection of Clinton Keith Road and Interstate 15. A more in-depth analysis is recommended to determine the best location.

- A 4,000 lineal foot 30-inch diameter pipeline on Corydon Street is required to convey groundwater when the Back Basin dual-purpose wells are in extraction mode. The capacity of existing pipelines is not sufficient to distribute the water directly in the Loop Zone.

Lake Level Maintenance

Maintenance of water levels in Lake Elsinore would be accomplished with a combination of recycled water and groundwater when the lake level drops below 1,240 feet MSL. Recycled water would be used as the primary source of replenishment water up to 17.7 mgd. This is the projected capacity of the Regional Plant in year 2020 minus 0.5 mgd reserved for discharge to Temescal Wash. One of the three Island Wells would be used as the secondary source when the recycled water supply is not adequate to maintain the lake level at 1,240 feet MSL in year 2020, while all three wells are required to maintain lake levels before year 2020 when less recycled water is available. Based on lake balance calculations as described in **Appendix E**, replenishment with groundwater would occur twice in 41 years with an average of five acre-ft/yr. It is recommended that EVMWD investigate the extension of the waste discharge permit with the Regional Board to enable the proposed use of recycled water in the future. In addition, it is recommended to study the potential of using recycled water from Eastern Municipal Water District for lake replenishment or serving non-potable demands within the District's service area.

Surface Spreading

Although the use of surface spreading facilities is not included in the recommended plan, it is recommended that EVMWD further investigate the possibilities of surface recharge in Railroad Canyon. Discussions between EVMWD and MWDSC are required to determine if raw water can be obtained from MWDSC at the turnout 12 miles upstream from Canyon Lake and then spilled over Railroad Canyon Dam to be infiltrated in the San Jacinto River before reaching Lake Elsinore. Access to State Water Project water is desirable due to its lower TDS. This source of lake replenishment water will indirectly offset the amount of Tier 2 water that needs to be purchased for potable demand needs, as more groundwater is preserved for potable water needs.

Use of Recycled Water

The recommended plan limits the use of recycled water to the use for lake replenishment as discussed above. However, the pipeline currently under design from the EMWD Temecula Regional plant to the Temescal Wash discharge location near Wasson Sill in the Lake outlet channel, will bring additional recycled water to EVMWD's service area when the production of recycled water exceeds EMWD's recycled water demand. This new recycled water source offers the potential for the expansion of recycled water use within the District's service area. Neither the use of EMWD recycled water nor the expansion of the recycled water system are included in this GWMP as this is beyond the scope of this project. The purpose of this component is to recognize that this additional recycled water source may be available. It is recommended that potential recycled water demands be identified and the feasibility of a dual water system be determined in a future recycled water planning study. An expansion of the use of recycled water may result in a reduced need for peaking wells. It should be noted that the availability of recycled water will increase with growth, and that the current shortage of recycled water is expected to change to an excess of recycled water in the future.

Advisory Committee

This plan recommends that an Advisory Committee should be formed that represents the users of the Elsinore Basin. This committee may consist of five members, with three members from EVMWD, one member from EWD, and one member representing the private pumpers in the Elsinore Basin. EVMWD's Board of Directors would appoint the members of the Advisory Committee. The Advisory Committee would be involved with the following programs and activities:

- Provide advise on the implementation of the Groundwater Management Plan
- Provide advise on the implementation of the Monitoring Program
- Provide advice on the development and implementation of Well Construction, Destruction, and Abandonment Policies.

The Advisory Committee shall provide their comments on these activities to the EVMWD Board of Directors.

Monitoring Program

As the Plan is implemented, the District's ongoing groundwater monitoring program will play an integral role in understanding the basin response to different plan elements. The effectiveness of the Plan will be measured through its impacts on groundwater levels, water quality and subsidence potential.

A basin monitoring program is important to better understand the groundwater basin and to measure the effects of the activities that are implemented. In addition, basin monitoring provides a basis for effective adaptive management. The monitoring program that is developed as part of this GWMP is presented as a separate document (MWH, 2003). The monitoring program incorporates the Joint Groundwater Monitoring Program that was established by the May 2000 agreement between EVMWD and EWD. The key components of the proposed monitoring plan are listed below and the locations of monitoring wells are identified in **Figure 8-2**.

- Conduct a well canvass to obtain information from private well owners. These additional background data can be used to further characterize the basin to guide EVMWD's future groundwater supply needs.
- Construct five new monitoring wells, three nested piezometer wells and two single wells. These wells will be used to obtain additional background water level and water quality data to characterize the basin. In addition, these wells can be used to monitor the impact of future facilities. One these five new monitoring wells was recently drilled at McVicker Canyon.
- Measure water levels in existing production and monitoring wells and the new monitoring wells on a monthly basis. Monthly data is important to understanding the seasonal variations in water levels throughout the basin and confirm the basin yield.
- Collect water quality data from the existing wells on an annual basis and the new monitoring wells two times annually. Changes in water quality may be caused by operations throughout the basin. New monitoring wells should be monitored more frequently to obtain background data for comparison to future water quality.

- Perform spinner logging to identify where most of the production comes from in existing production wells. These data may indicate the depth to which new production wells should be drilled in the future.
- Perform water quality zone testing, in conjunction with the spinner logging. This analysis can be used to isolate which areas are causing variations in water quality. This may include continuous water quality logging or zone specific testing.
- Perform continuous aquifer testing. The data can be used to confirm transmissivity and storativity estimates that can used to estimate future drawdown and basin yield.
- Perform surface water monitoring of Lake Elsinore, the San Jacinto River and Leach and McVicker Canyons
- Perform land subsidence monitoring, which should initially consist of a GPS monument network

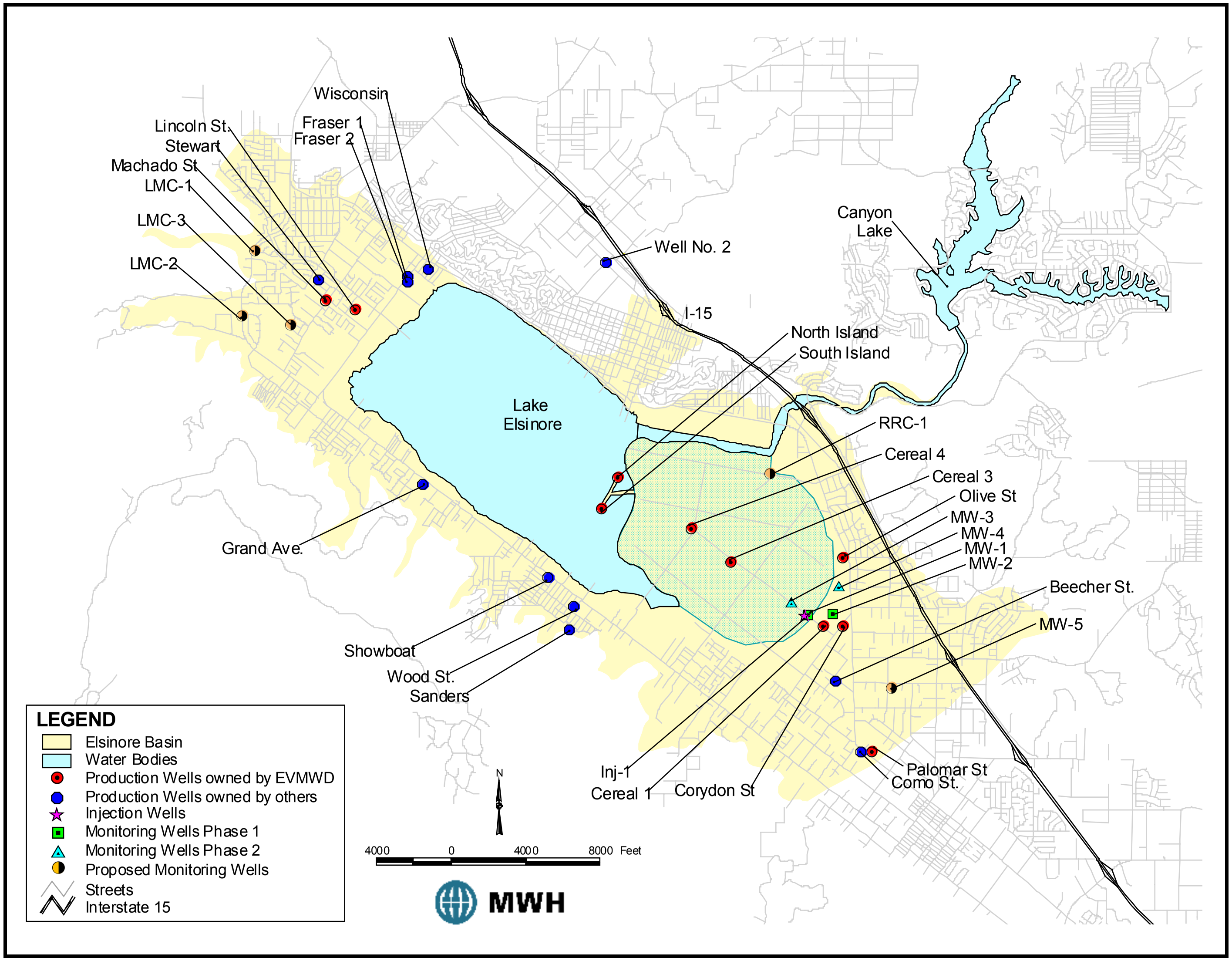
The information collected through this monitoring program will lead to more efficient implementation of management activities, as it would provide guidance for adjusting management parameters according to the results over time. The data collection will play an integral role in the District's understanding of the basin's response to different plan elements and provide a baseline that can be used to evaluate the success of the GWMP and other projects. Information gathered on the effectiveness of individual plan element can be used for future updates of the GWMP.

Well Construction, Destruction and Abandonment Policies

Improperly constructed wells can result in poor yield and contaminated groundwater by establishing a pathway for pollutants to enter a well, allow communication between aquifers of varying quality, or the unauthorized disposal of waste into the well. This GWMP recommends that well construction, destruction, and abandonment policies be developed in cooperation with Riverside County. These policies should include the following principles:

- All wells drilled in the Elsinore Basin must be in compliance with the California Water Code §13700 through §13806
- All well drilling contractors must be in possession of an active C-57 Contractor’s license.
- Permits for the drilling, deepening, modification, or repair of any well must be obtained and be in accordance with Riverside County Ordinance 682.3. These permits should conform to well construction standards that are specified in DWR Bulletins 74-81 and 74-90.
- All wells within the Elsinore Basin, whether active, inactive, abandoned or improperly destroyed, should be identified by conducting a well canvass. All identified wells should be included in the groundwater GIS.
- The status of all wells should be evaluated to identify which wells should be destroyed and which wells can be capped or retained as monitoring wells. If no future use is anticipated, wells must be properly destroyed according to the destruction procedures are also specified in the DWR Bulletins 74-81 and 74-90. If future use is anticipated, wells can be capped and maintained as outlined in Riverside County Ordinance 682.3.
- Coordination between Riverside County and the District should take place to ensure that property owners, who are responsible for proper well destruction and capping of wells, follow the destruction procedures and guidelines.

Figure 8-2
Location of Monitoring Wells



Septic Tank Conversion Plan and Policies

The recommended plan presumes that at least all septic tanks in the high-risk zone, as shown in **Figure 5-2**, should be connected to the sewer system by year 2020. Approximately 2,900 septic tanks, which is about 80 percent of all the septic tanks in the basin, are located in this high-risk zone and need to be connected to the sewer system, while no additional septic tanks are added within the high-risk zone. The District is currently developing the policies to accomplish the conversion of at least all septic tanks is the high-risk zone.

IMPLEMENTATION

The implementation plan consist of a discussion of the project cost, financing options, phasing of activities, phasing of cost, operation of the basin, and agency coordination.

Costs of the Recommended Plan

The total capital and annual costs of the recommended plan are summarized in **Table 8-2**.

Table 8-2
Summary of Capital and Annual Cost

Cost Type	Project Description		Capital Cost	Annual Cost
Capital Cost	4 Peaking Wells		$ 7,480,000	$ 194,000
	6 Conversion of Existing Wells to Dual Purpose Wells		$ 600,000	$ 37,000
	Equipping Joy Street as a Dual Purpose Well		$ 100,000	$ 7,000
	7 New Dual Purpose Wells		$ 13,090,000	$ 339,000
	30-inch diameter pipeline on Corydon Street (4,000 LF)		$ 1,360,000	$ 50,000
	800 HP in-line PS (near Clinton Keith Rd./I-15)		$ 1,680,000	$ 103,000
	Subtotal		**$ 24,310,000**	**$ 730,000**
O&M Cost	**Quantity (acre-feet/yr)**	**Cost Item**		**Annual Cost**
	8,188	Groundwater Pumping in Back Basin Area		$ 691,000
	2,132	Groundwater Pumping N/O Lake		$ 166,000
	380	Groundwater Pumping EWD		$ 31,000
	0	Groundwater Pumping for Lake Replenishment		$ -
	3,400	Recycled water for Lake Replenishment		$ 510,000
	3,000	Canyon Lake WTP		$ 690,000
	13,320	Purchase of MWD Water (Tier 1)		$ 5,568,000
	19,880	Purchase of MWD Water (Tier 2)		$ 9,921,000
	5,900	Purchase of MWD Water for Injection		$ 1,770,000
	1,100	Purchase of MWD Water for In-Lieu recharge		$ 330,000
	12,000	Pumping Cost in-line PS (near Clinton Keith Rd./I-15)		$ 232,000
	2,500	Water Conservation		$ 650,000
	71,800	**Subtotal**		**$ 20,559,000**
Total				**$ 21,472,000**

As shown in this table, the total capital costs are $24.3 million, which corresponds to an annual investment of $0.73 million at a discount rate of 3 percent. Other annual cost include $0.9 million for groundwater pumping, and $17.6 million for the purchase of imported water from MWDSC, and $2.0 million for others. The total annual costs are $20.6 million, which equals $422 per acre-foot of base water demand.

Funding Options

The primary beneficiaries of the GWMP are the municipal water users in the Elsinore Basin, EVMWD and EWD. Private pumpers throughout the basin with generally small domestic demands will either be beneficially impacted or experience no impacts. The plan's cost should be allocated between the existing users and future growth-related users (through connection fees). As Elsinore Basin groundwater is supplied to customers outside the basin area, all customers in the entire combined service area of the District and EWD should pay for the cost of this plan. Cost savings experienced by local private pumpers should be an incentive to participate in the implementation of this GWMP. The capital cost required for structural improvement projects need to be financed by the District and recovered based on the sale of water. As shown in the cost comparison in **Section 7**, the unit cost of implementing the recommended plan of the GWMP is about the same as the continuation of current operations as presented in Baseline B, thus funding of the plan is not anticipated to be an issue. However, the recommended plan requires that most of the investments are made early on, while the cost of Baseline B are more equally spread over time. The capital cost of the recommended plan is $31 million lower than Baseline B. Mechanisms for financing include the following:

- Water rates
- General property taxes
- Grants, such as DWR construction grants
- Developer fees

It is not possible to predict the specific financing mechanisms that will be applied to each of the elements of the recommended plan. Funding will likely be through a combination of mechanisms that best meet the needs of the District. Public input regarding financing options should be sought as specific items are proposed or constructed.

Phasing of Activities

An implementation plan has been developed which describes the phasing of the various project components over the next twenty years. The phasing of this project and other components is presented in **Figure 8-3**.

The following factors are considered per project in the phasing of project components:

- The impact of the project on the groundwater balance
- The estimated construction time
- The need for the project in relation to the water demands
- The distribution of cost over time

Figure 8-3
Phasing of Activities

Project	2003-2005	2006-2010	2011-2015	2016-2020
4 Peaking Wells				
Conversion of 6 Existing Wells to Dual Purpose Wells				
Equipping Joy Street as a Dual Purpose Well				
7 New Dual Purpose Wells				
30-inch diameter pipeline on Corydon Street (4,000 LF)				
800 HP in-line PS (near Clinton Keith Rd./I-15)				
Water Conservation				

The implementation of dual-purpose wells in the Back Basin has already started with pilot testing. Design of the full-scale facilities is underway as part of a grant application under Proposition 13. To allow injection of treated imported water as soon as possible, it is recommended that the all dual purpose wells and the associated booster station be implemented as soon as possible. As shown in Figure 8-3, all related projects are phased for the period 2003-2005. The pipeline at Corydon Street is postponed till the period 2006-2010 as the need for this pipeline is demand-driven and is required for extraction only. The current well configuration is assumed to be sufficient to meet MDD till at least 2005. With the installation of the eight new dual-purpose wells (Joy Street and seven new dual-purpose wells), the available supply capacity is increased and can meet MDD up to year 2018. The four peaking wells are therefore phased in the last period, 2016-2020. Water conservation is an on-going effort as many of the water conservation measures are focussed on public participation, which needs to be carried out continuously to include the future growth-related customers.

Phasing of Cost

Based on the phasing of activities as described above, the distribution of capital investments is calculated and presented in **Table 8-3**. This table does not include annual cost and can be used to update the District's Capital Improvement Program and rate studies.

Table 8-3
Phasing of Capital Cost (in $1,000)

Project	2003-2005	2006-2010	2011-2015	2016-2020
4 Peaking Wells	$ -	$ -	$ -	$ 7,480
Conversion of 6 Existing Wells to Dual Purpose Wells	$ 600	$ -	$ -	$ -
Equipping Joy Street as a Dual Purpose Well	$ 100	$ -	$ -	$ -
7 New Dual Purpose Wells	$ 13,090	$ -	$ -	$ -
30-inch diameter pipeline on Corydon Street (4,000 LF)	$ -	$ 1,360	$ -	$ -
800 HP in-line PS (near Clinton Keith Rd./I-15)	$ 1,680	$ -	$ -	$ -
Total	**$ 15,470**	**$ 1,360**	**$ -**	**$ 7,480**

As shown in this table, the capital investments are not evenly distributed over time. Deferring a portion of the injection projects is possible, for example the wells in the area north of Lake Elsinore; however, the groundwater basin is managed best when injection takes places at both locations. In addition, deferring the implementation of dual-purpose wells will advance the need for peaking wells. Since the cost of new dual-purpose wells and peaking wells are the same, deferring the injection projects would not change the cost distribution significantly.

Operation of the Basin

The basin will require an operation plan that varies over the time. The GWMP provides an operational strategy for the demand conditions in year 2020. The operation plan would address the operational strategy under various supply and demand scenarios for the intermediate periods, as demands and available supplies vary over time. This plan would also include an emergency supply plan that describes the system operations under drought conditions.

The in-lieu operation of the basin can start immediately, provided that MWDSC has replenishment water available. Once the dual-purpose wells and associated facilities are in place, conjunctive use operations can start to recharge the groundwater basin during wet periods and provide storage for dry periods. In general, injection would take place between October and March in years when replenishment water is available, which depends on the hydrologic conditions of the sources that contribute to MWDSC's overall supply. It should be noted that injection may be possible year around during wet years if excess replenishment water is available. The dual-purpose wells would be used for extraction in the summer months of dry years when the demands increase and the available imported supply from MWDSC decreases. The injection and extraction cycles of the recommended plan as a function of the hydrologic conditions of 1960 through 2001 are presented in **Figure 6-7**. During the 41-year hydrologic cycle, about 240,000 acre-feet of imported water would be injected. With these operations, the groundwater basin remains in a long-term balance, meaning that the amount extracted is equal to the amount replenished over the 41-year hydrologic analysis period. To exercise all the wells regularly, cycling the use of dual-purpose wells for extraction along with the regular production wells is recommended. The use of groundwater for lake replenishment is very limited in the recommended plan. This is discussed in more detail under Lake Level Maintenance.

The water supply distributions for the year 2020 demands in an average, wet and a dry year are presented in **Figure 6-8**. As shown in this figure, the peaking wells are only required in dry years, when demands increase, and when the production of Canyon Lake WTP is almost zero. To provide a more detailed picture of the conjunctive use operation in the recommended plan, the water supply mix during average rainfall years, wet years and dry years are presented on a monthly basis in **Figure 8-4**, **Figure 8-5**, and **Figure 8-6** respectively.

These figures indicate the need for additional peaking wells to meet the water demand in the summer months under dry year conditions. During average rainfall and wet years, peaking wells are likely to be needed as well on to meet MDD, as the graphs only present the average demand of the summer months, which is about 20 percent lower than MDD. Figure 8-6 shows that the injection potential is zero in dry years, while during average and wet years injection can take place from October through March. The system demands in October require full use of the imported water connection capacity; hence, injection can not take place. Once the demands drop, the imported water can be used for groundwater recharge.

Figure 8-4
Water Supply Mix during an Average Rainfall Year

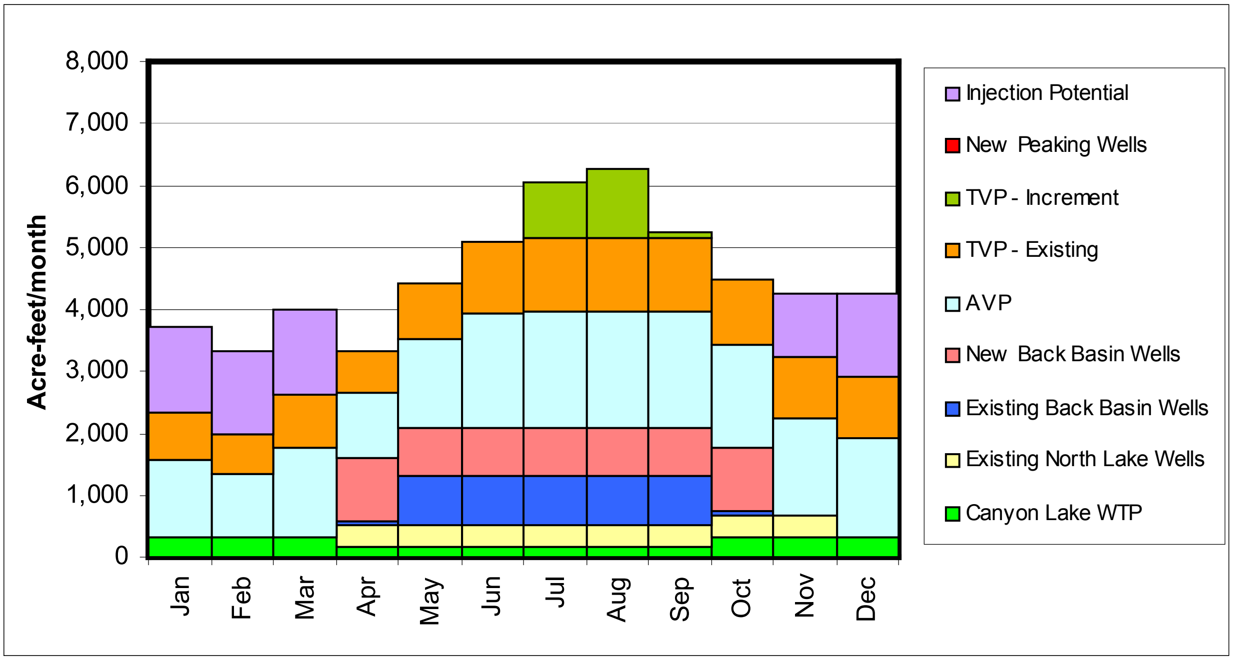


Figure 8-5
Water Supply Mix during a Wet Year

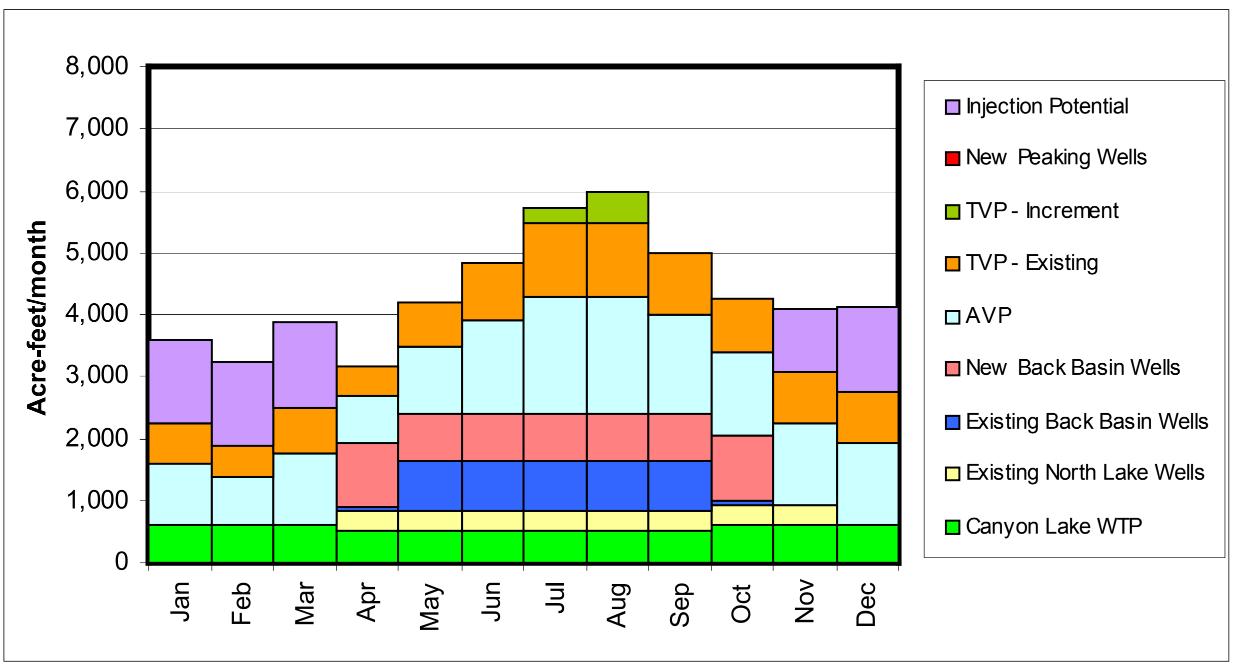
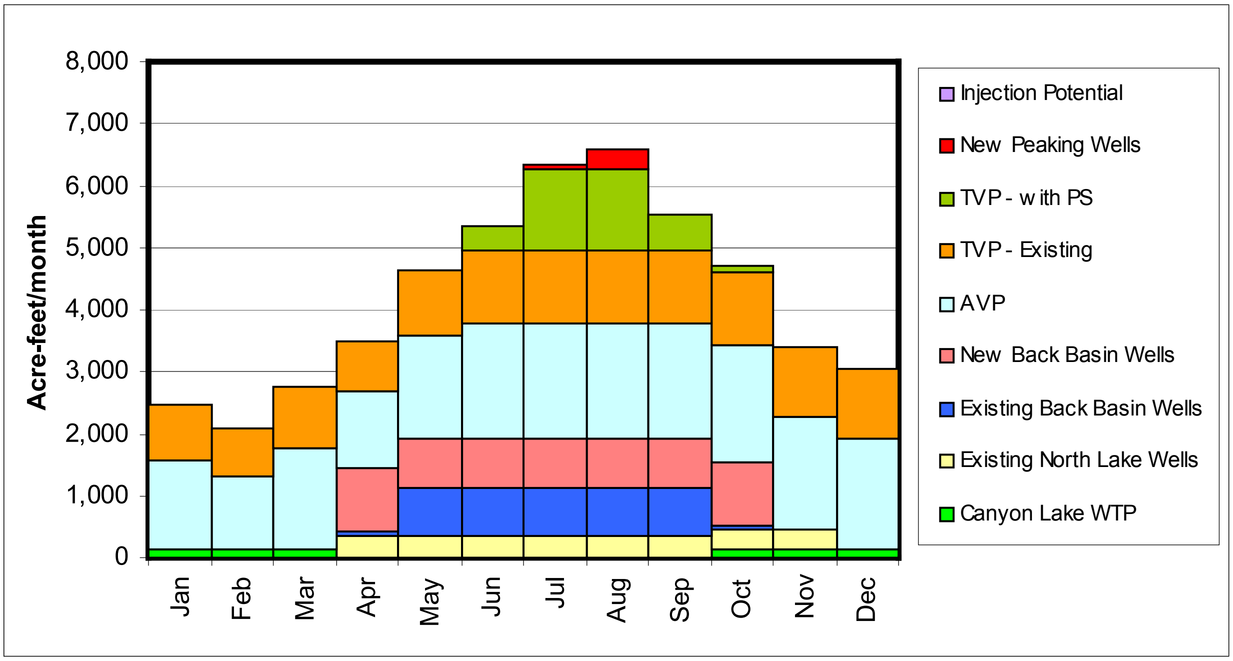


Figure 8-6
Water Supply Mix during a Dry Year



The graphs also show the difference in production of Canyon Lake WTP. During wet years, the TVP pumping station needs to operate two months per year, while this increase to four months under dry year conditions. Injection is estimated to take place in eight out of ten years.

Agency Coordination

For successful implementation of this GWMP, coordination of activities, plans and programs between the District and other agencies is required. **Table 8-4** summarizes the agencies involved and the associated activities that are described under the recommendations of the recommended plan earlier in this section.

CONCLUSION

The goal of the Elsinore Basin GWMP is to ensure a reliable, high quality, cost-efficient, groundwater supply for the users of the Elsinore Basin in an environmentally friendly manner. If the Plan is to succeed, it must be a living document that is flexible and can be adapted to meet the changing needs of the Elsinore Valley area. As management elements are established and results of implementation strategies are quantified, the GWMP should be periodically evaluated to determine how well it is meeting the needs of the Elsinore Valley area, to consider new information and opportunities, and if needed to make appropriate adjustments. Along with the GWMP, an environmental document pursuant to CEQA should be prepared that evaluates the environmental impacts of the recommended plan.

Table 8-4
Summary of Agency Coordination

Agency and Basin Users	Activities/Plan/Programs that require Coordination
Advisory Committee	• Monitoring Program • Well Construction, Destruction, and Abandonment Policies • Septic Tank Conversion Policies • Feedback on the GWMP to the District Board of Directors
City of Lake Elsinore	• Lake Level Maintenance Agreement (Lake Elsinore)
DWR	• Well logs • Possible Grant Opportunities
EMWD/RCWD	• Construction of Reclaimed Water Pipeline • Availability of Reclaimed water
EWD	• Joint Groundwater Monitoring Program • Enhanced Monitoring Program of GWMP
Private Pumpers	• Well Canvass • Well Destruction/Capping of Wells
Riverside County	• Permits for the drilling, deepening, modification or repair of wells • Well Destruction/Capping of Wells • Planning Documents (e.g. general and specific plans)
RWQCB	• Groundwater Contamination Notices • Revisions of the Santa Ana Basin Plan Objectives • Reclaimed water projects • Current discharge of Reclaimed water in Lake Elsinore • NPDES permit
SWRCB	• Production records of public and private pumpers

The next step is a public review of the GWMP. Public forums and workshops will invite input from the general public, taxpayers, water users, local governments, federal and state agencies. Public review may result in modifications to the recommended plan. Actions needed to ensure that the recommended plan meets the objectives of the GWMP require commitment, consensus, and cooperation from all water users of the Elsinore Basin. The success of this GWMP will allow the Elsinore Valley to grow and double its demands over the next 20 years, with a reliable, affordable, and stable water supply.

Appendix A
References

American Society of Civil Engineers, 1987. *Ground Water Management*, ASCE Manual and Reports on Engineering Practice No. 40.

Ayres Associates, *An Evaluation Of Sunset Park Landscape Irrigation System Conservation Program* prepared for the City of Tampa, 1995. http://www.ficus.usf.edu/docs/water_conserve/

Ayres Associates, *Single-Family Residential Toilet Rebate Program Evaluation* prepared for the City of Tampa, 1994. http://www.ficus.usf.edu/docs/water_conserve/

Ayres Associates, *The Impact Of Water Conserving Plumbing Fixtures On Residential Water Use Characteristics* prepared for the City of Tampa, 1993.

Black and Veatch, *Back Basin Study* prepared for Elsinore Valley Municipal Water District, June 1995.

Bouwer, H., *Causes of Infiltration decreases in systems for artificial recharge*.

California Code of Regulations, Title 22, 2003. Drinking Water Regulations Title 22, 2003.

California Code of Regulations, Sections 10752-10754, Water Code.

California Code of Regulations, Sections 65601-65607, Water Recycling in Landscaping Act.

California Code of Regulations, Sections 65591-65600, Water Conservation in Landscaping Act

California Regional Water Quality Control Board Santa Ana Region, 1995. Water Quality Control Plan Santa Ana River Basin (Basin Plan)

California Department of Water Resources, 1981. Investigation of Ground Water Supply for Stabilization of Level of Lake Elsinore, Riverside County.

California Department of Water Resources, 2000. A Guide to Estimating Irrigation Water Needs of Landscape Plantings in California.

California Department of Water Resources, 2002. Unpublished driller's logs.

California Division of Mines and Geology, 1969. Geologic Atlas of California. Santa Ana Sheet.

California State Water Resources Board, 1953. Elsinore Basin Investigation, Bulletin 9, 105p.

California State Water Resources Board, 1959. Santa Ana River Investigation, Appendix B, Geology of San Jacinto and Elsinore Basins, Bulletin 15.

California Water Code Section 4999-5008, http://www.leginfo.ca.gov/

California Water Code, Sections 10610-10656, http://www.leginfo.ca.gov/

CH2MHill, *Technical Memorandum No. 4 – Lake Elsinore Historic Inflows* prepared for Elsinore Valley Municipal Water District, December 2002.

CH2MHill, *Water Resources Management Plan – Phase 1 Existing Water Supply System Assessment* prepared for the agencies in the Fresno/Clovis Metropolitan Area, January 1992.

CH2MHill, *Water Resources Management Plan – Phase 2 Water Supply Alternatives* prepared for the agencies in the Fresno/Clovis Metropolitan Area, May 1992.

CH2MHill, *Water Resources Management Plan – Phase 2 Implementation Plan* prepared for the agencies in the Fresno/Clovis Metropolitan Area, May 1994.

City of Lake Elsinore, *Lake Elsinore General Plan*, 1990.

Department of Water Resources, Washoe County, Nevada, Sewering Project of Spanish Springs, http://www.co.washoe.nv.us/water_dept/ss_sewer/index.htm

East Bay Municipal Utility District, *Landscape Comparison Survey,* 1992

East Bay Municipal Utility District, *Water Conservation Market Penetration Study*, 2002, http://waterresources-inc.com/ExecSumm.pdf/

EPA, *The Class V Underground Injection Control Study*, Volume 21 Aquifer Recharge and Aquifer Storage and Recovery Wells, September, 1999.

EVWMD, *Groundwater Management Plan West San Jacinto Groundwater Basin*, June, 1995.

EVMWD, District website http://www.evmwd.com, 2003.

EVWMD and EWD, 2000. Monitoring and Mitigation Program – Elsinore Valley Groundwater Basin.

Federal Energy Policy Act of 1992 (PL 102-486)

Fox, Robert C, 1991b. Summary of Well Construction Cereal Street Well No. 3 Prepared for Elsinore Valley Municipal Water District

Fox, Robert C., 1984. Summary of Water Well Construction. Lincoln Street Well No. 2. Prepared for Elsinore Valley Municipal Water District.

Fox, Robert C., 1985. Aquifer Test on the Corydon Street Well Field. Prepared for Elsinore Valley Municipal Water District.

Fox, Robert C., 1991a. Summary of Well Construction Cereal Street Well No. 4. Prepared for Elsinore Valley Municipal Water District

Fox, Robert ., 1999. Groundwater in Storage – Lake Elsinore Groundwater Basin. Prepared for Elsinore Valley Municipal Water District, April.

GDS Associates Inc., *Quantifying the Effectiveness of Various Water Conservation Techniques in Texas* prepared for the Texas Development Board, 2000.

Geoscience Support Services, Inc, 1994. Ground Water Recharge Feasibility Study Final Report. Prepared for Elsinore Valley Municipal Water District.

Geoscience Support Services, Inc., 1999. Detailed Technical Specifications for the Machado Street Well. Prepared for Elsinore Valley Municipal Water District.

Harding-Lawson Associates, 1978. Elsinore Valley Gravity Study. Unpublished Report. Prepared for California DWR. 20p.

Harding-Lawson Associates, 1980. Elsinore Lake Geophysical Survey. Unpublished Report. Prepared for California DWR, 28p.

http://www.ficus.usf.edu/docs/water_conserve/

http://www.mwd.dst.ca.us/mwdh2o/pages/yourwater/ccr02/ccr07.html, 2003

http://www.twdb.state.tx.us/assistance/conservation/gdsstudy.htm/

James M. Montgomery, *Reclaimed/Non-potable Water Master Plan* for Elsinore Valley Municipal Water District, April 1992.

Kennedy/Jenks Consultants, *Drinking Water Source Assessment and Protection Plan* for Elsinore Valley Municipal Water District, March 2002.

Kennedy-Jenks Consultants, 2002. Wastewater Master Plan. Prepared for Elsinore Valley Municipal Water District.

Kennedy-Jenks Consultants, 2002. Drinking Water Source Assessment and Protection Plan. Prepared for Elsinore Valley Municipal Water District.

LADWP Website: http://www.ladwp.com/water/conserv/, 2003

Logan, J., 1964. Estimating Transmissibility from Routine Production Tests of Production Wells, *Groundwater*, Vol 2, No. 35, 35-37.

Means, RS, 2003. Heavy Construction Data – 17th Annual Edition.

MWH (formerly Montgomery Watson) in association with Maddaus Water Management and The Weber Group, *Urban Water Management Plan* prepared for Elsinore Valley Municipal Water District, January, 2000.

MWH (formerly Montgomery Watson), *NPDES Permit for Discharge to Lake Elsinore – Engineering Feasibility Study* for Elsinore Valley Municipal Water District, February 2002.

MWH (formerly Montgomery Watson), *Water Resources Development Plan* prepared for Elsinore Valley Municipal Water District, February 1997.

MWH *Elsinore Basin Recharge Feasibility Study – Draft* prepared for Elsinore Valley Municipal Water District, 2003.

MWH *Coachella Valley Final Water Management Plan* prepared for Coachella Valley Water District, September 2002.

MWD Annual Water Quality Report 2001, MWD Website

MWD Website: http://www.mwd.dst.ca.us/mwdh2o/pages/conserv/program02.html, 2003

MWH (formerly Montgomery Watson), *Distribution System Master Plan* prepared for Elsinore Valley Municipal Water District, May 2002.

MWDSC, 2003. Investments to Protect, Ensure Water Quality Drive First Increase in Cost of Treated Water in Seven Years. Published on http://www.mwd.dst.ca.us/mwdh2o/pages/news/press_releases/2003-03/WaterQuality.htm.

Neblett & Associates, 1998. Fault Investigation – Liberty Development Project Phase I – Lake Elsinore California. Prepared for TMC Communities.

Neblett & Associates, 1999. Geotechnical Review and Hydrogeologic Assessment – Concept Grading Plan – Liberty Development Project. Prepared for The Town Group, Irvine CA.

New Brunswick Environmental Trust Fund , Septic Tanks Conversion Program of the New Brunswick Environmental Trust Fund and the Chaleur Bay Watersheds.

Regional Water Quality Control Board, 1995. Santa Ana River Basin Plan.

Regional Water Quality Control Board, 2003. http://www.geotracker.swrcb.ca.gov/casereports

Regional Water Quality Control Board, 2003. Personal communication with MWH. April, 2003.

Riverside County Flood Control and Water Conservation District, Isohyetal Map of Average Annual Precipitation.

Riverside County Flood Control District, 1978. Hydrology Manual.

Riverside County Flood Control District, 2002. Precipitation and stream gauge data.

Riverside County, *Riverside County Comprehensive General Plan*, 1994.Riverside County Water Budget Formula, 2001.

State of California Water Resources Control Board, 1991. Information Relating to Recordation of Water Extractions and Diversions (91-3 WR).

Todd, D.K., 1980. *Groundwater Hydrology, Second Edition.* New York: John Wiley and Sons.

Tsuchihashi, R., Sakaji, R., Asano, T., 2002. Health Aspects of Groundwater Recharge with Recycled Water. Hawaii Water Environment Association, 2002 Reuse Conference.

University of California Davis, Information Center for the Environment ICE MAPS. Published at: http://icemaps.des.ucdavis.edu/icemaps2/ICEMapInit.html

Waterloo Hydrogeologic, 2002. Visual MODFLOW PRO v. 3.0, build 180.

Appendix B
List of Abbreviations

The abbreviations used in this report are listed in **Table B-1**.

Table B-1
List of Abbreviations

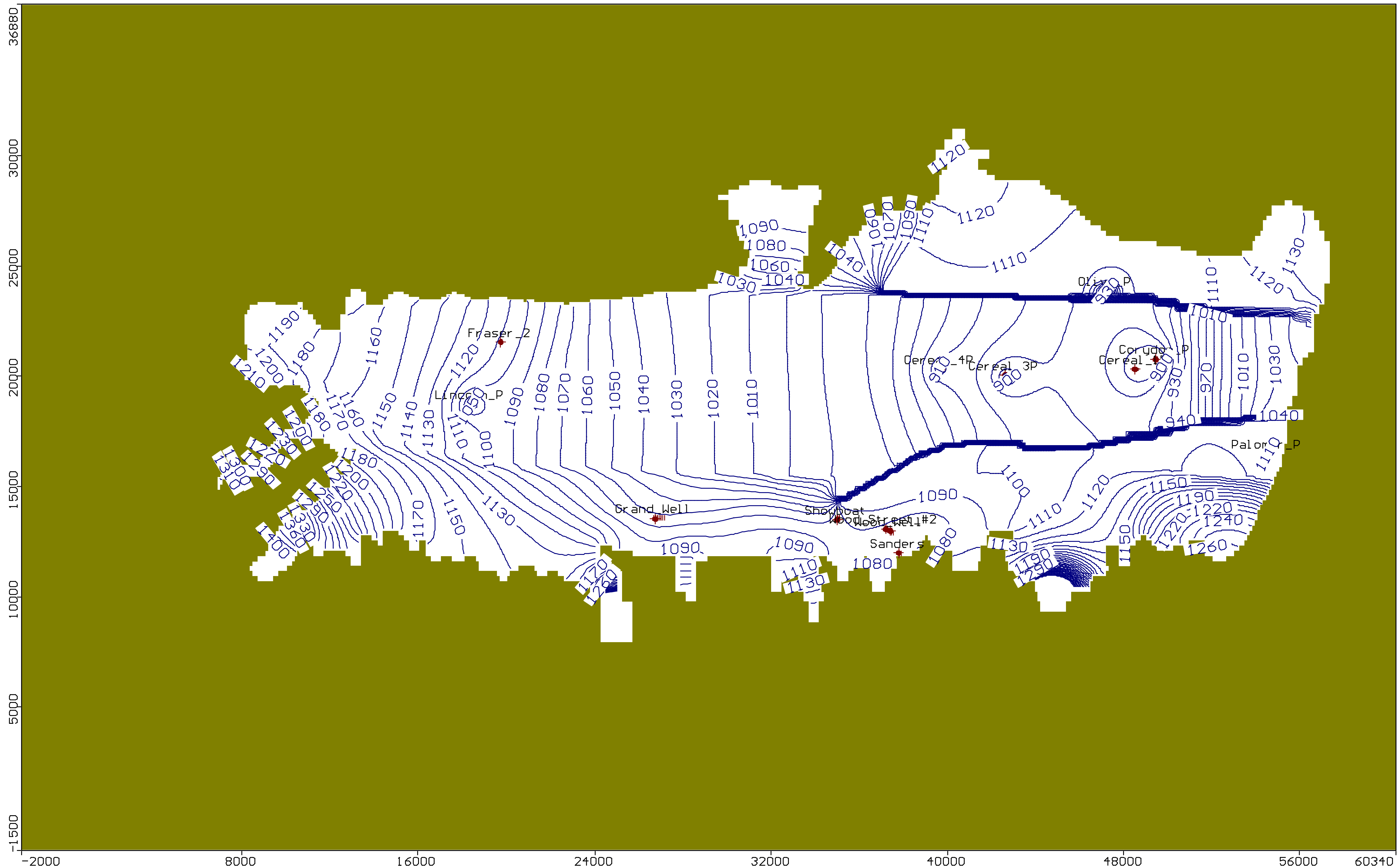
Abbreviation	Description
acre-ft/yr	Acre-feet per Year
ADD	Average Day Demand
APN	Assessor's Parcel Number
ASR	Aquifer Storage and Recovery
AVP	Auld Valley Pipeline
BBIPP	Back Basin Injection Pilot Project
BMP	Best Management Practices
CAFG	California Department of Fish and Game
CCI	Construction Cost Index
CEQA	California Environmental Quality Act
CPT	Cone Penetrometer Test
CY	Cubic Yard
DHS	Department of Health Services
DWR	Department of Water Resources
EIR	Environmental Impact Report
EMWD	Eastern Municipal Water District
ENR	Engineering News Record
EPA	Environmental Protection Agency
ESRI	Environmental Systems Research Institute
ET	Evapotranspiration
EVMWD	Elsinore Valley Municipal Water District
EWD	Elsinore Water District
FCD	Flood Control District
GIS	Geographic Information System
GMA	Groundwater Management Agency
GWMP	Groundwater Management Plan
HE	High Efficiency
I-15	Interstate 15
LADWP	Los Angeles Department of Water and Power
MCL	Maximum Contaminant Level
MDD	Maximum Day Demand
mgd	million gallons per day
mg/L	milligram per liter
MDD	Maximum Day Demand
MMD	Maximum Monthly Demand
MOU	Memorandum of Understanding

Table B-2 (Continued)
List of Abbreviations

Abbreviation	Description
MSL	Mean Sea Level (feet)
MWDSC	Metropolitan Water District of Southern California
MWH	Montgomery Watson Harza
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and Maintenance
PEIR	Program Environmental Impact Report
psi	Pounds per square inch
RCFCD	Riverside County Flood Control District
RCFCWCD	Riverside County Flood Control and Water Conservation District
RCWD	Rancho County Water District
RWQCB	Regional Water Quality Control Board
RWWTP	Regional Wastewater Treatment Plant
SAWPA	Santa Ana Watershed Project Authority
SJRWT	San Jacinto River Raw Water Turnout
SWP	State Water Project
SWRCB	State Water Resources Control Board
TBD	To be determined
TDS	Total Dissolved Solids (mg/L)
TRC	Technical Review Committee
TVP	Temescal Valley Pipeline
ULF	Ultra Low Flow
USFWS	United States Fish and Wildlife Services
USGS	United States Geological Survey
UWMP	Urban Water Management Plan
WCFSP	Water Conservation Field Serviced Program
WTP	Water Treatment Plant
WWTP	Wastewater Treatment Plant

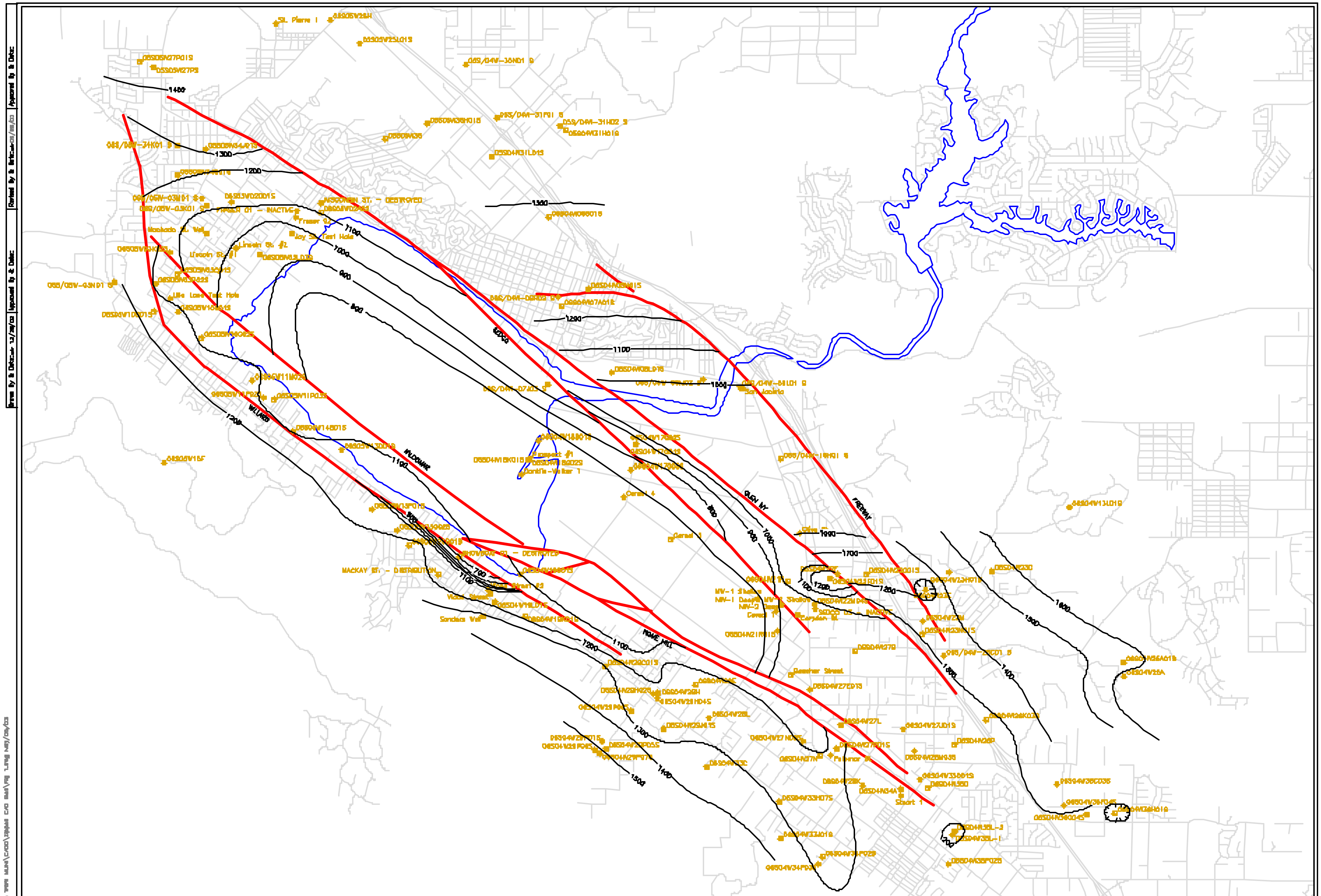
HSW Engineering
Project: Elsinore
Description: Model Layer 1 (1730days)
13 Jun 03

Visual MODFLOW v.3.1.0, (C) 1995-2002
Waterloo Hydrogeologic, Inc.
NC: 382 NR: 158 NL: 4
Current Layer: 1



HSW Engineering
Project: Elsinore
Description: Model Layer 3 (1730days)
13 Jun 03

Visual MODFLOW v.3.1.0, (C) 1995-2002
Waterloo Hydrogeologic, Inc.
NC: 382 NR: 158 NL: 4
Current Layer: 3



LEGEND

FAULT (KNOWN)

WATER BODY BOUNDARY

FORMATION NOT PRESENT

NOTES:

CONTOUR INTERVAL 100 FEET

CONTOURS DASHED WHERE INFERRED

0 3000 6000

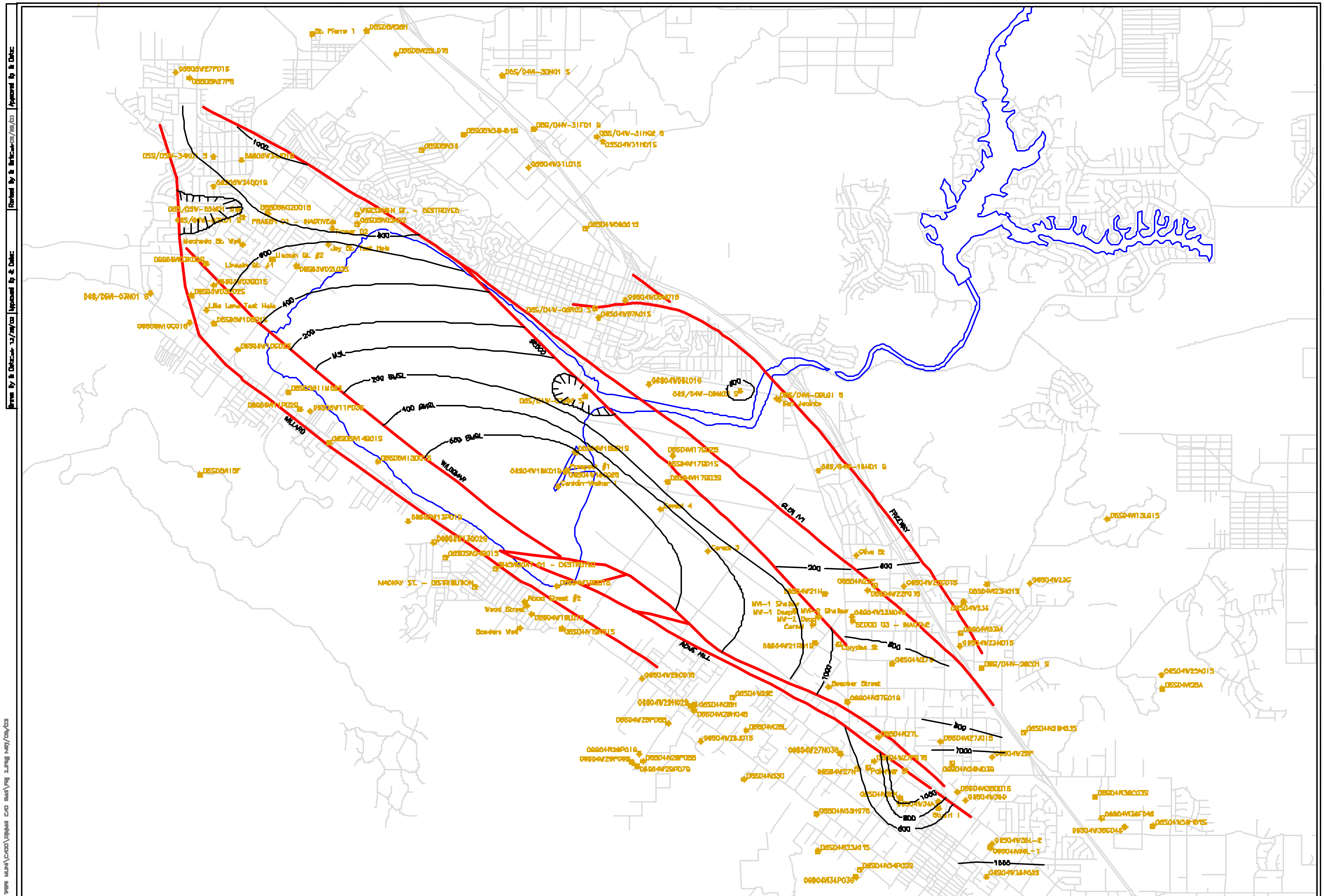
1" = 3000'

ELSINORE VALLEY MUNICIPAL WATER DISTRICT
ELSINORE BASIN, CALIFORNIA

STRUCTURAL CONTOUR MAP OF
BASE OF ALLUVIUM (Qal & Qt)

FIGURE C-1

MWH



LEGEND

- FAULT (KNOWN)
- WATER BODY BOUNDARY
- FORMATION NOT PRESENT

NOTES:

CONTOUR INTERVAL 200 FEET

CONTOURS DASHED WHERE INFERRED

0 3000 6000

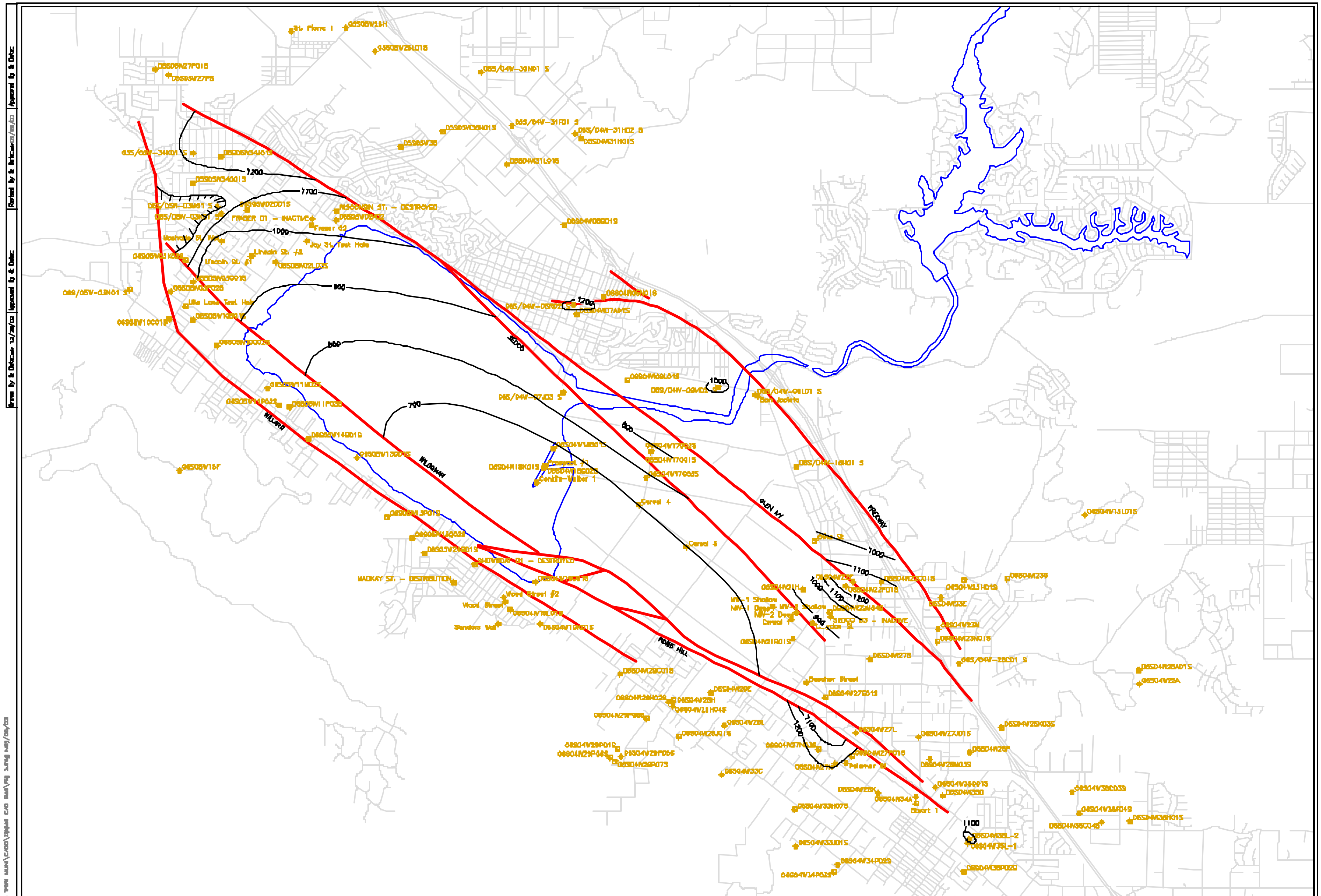
1" = 3000'

ELSINORE VALLEY MUNICIPAL WATER DISTRICT
ELSINORE BASIN, CALIFORNIA

STRUCTURAL CONTOUR MAP OF
BASE OF FERNANDO GROUP (TQf)

FIGURE C-2

MWH



LEGEND

FAULT (KNOWN)

WATER BODY BOUNDARY

FORMATION NOT PRESENT

NOTES:

CONTOUR INTERVAL 100 FEET

CONTOURS DASHED WHERE INFERRED

0 3000 6000

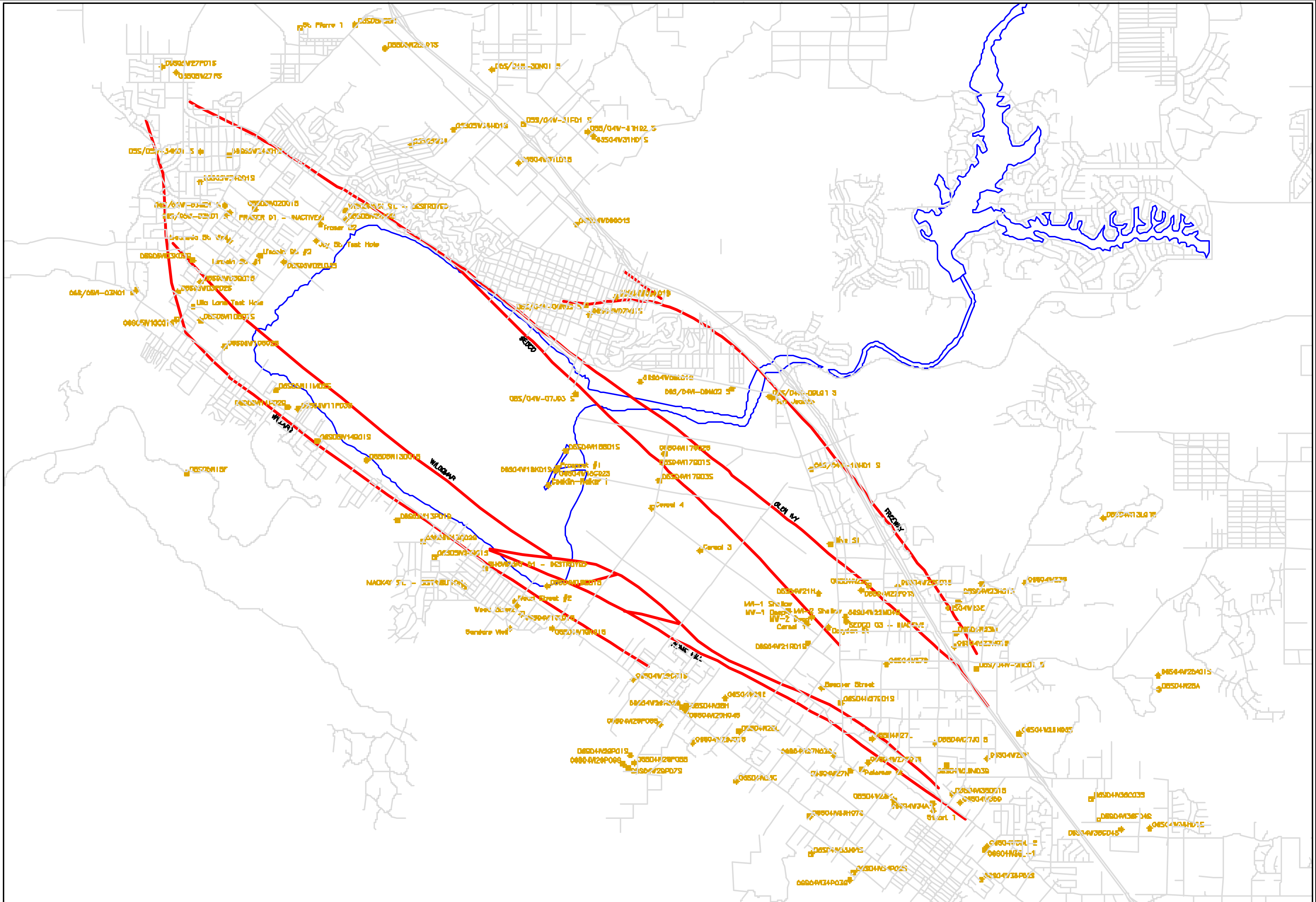
1"= 3000'

ELSINORE VALLEY MUNICIPAL WATER DISTRICT
ELSINORE BASIN, CALIFORNIA

STRUCTURAL CONTOUR MAP OF
BASE OF AQUITARD (Aq1)

FIGURE C-3

MWH



LEGEND

- FAULT (KNOWN)
- WATER BODY BOUNDARY

NOTES:

CONTOUR INTERVAL 200 FEET
CONTOURS DASHED WHERE INFERRED
MSL = MEAN SEA LEVEL
BMSL = BELOW MEAN SEA LEVEL

0 3000 6000
1" = 3000'

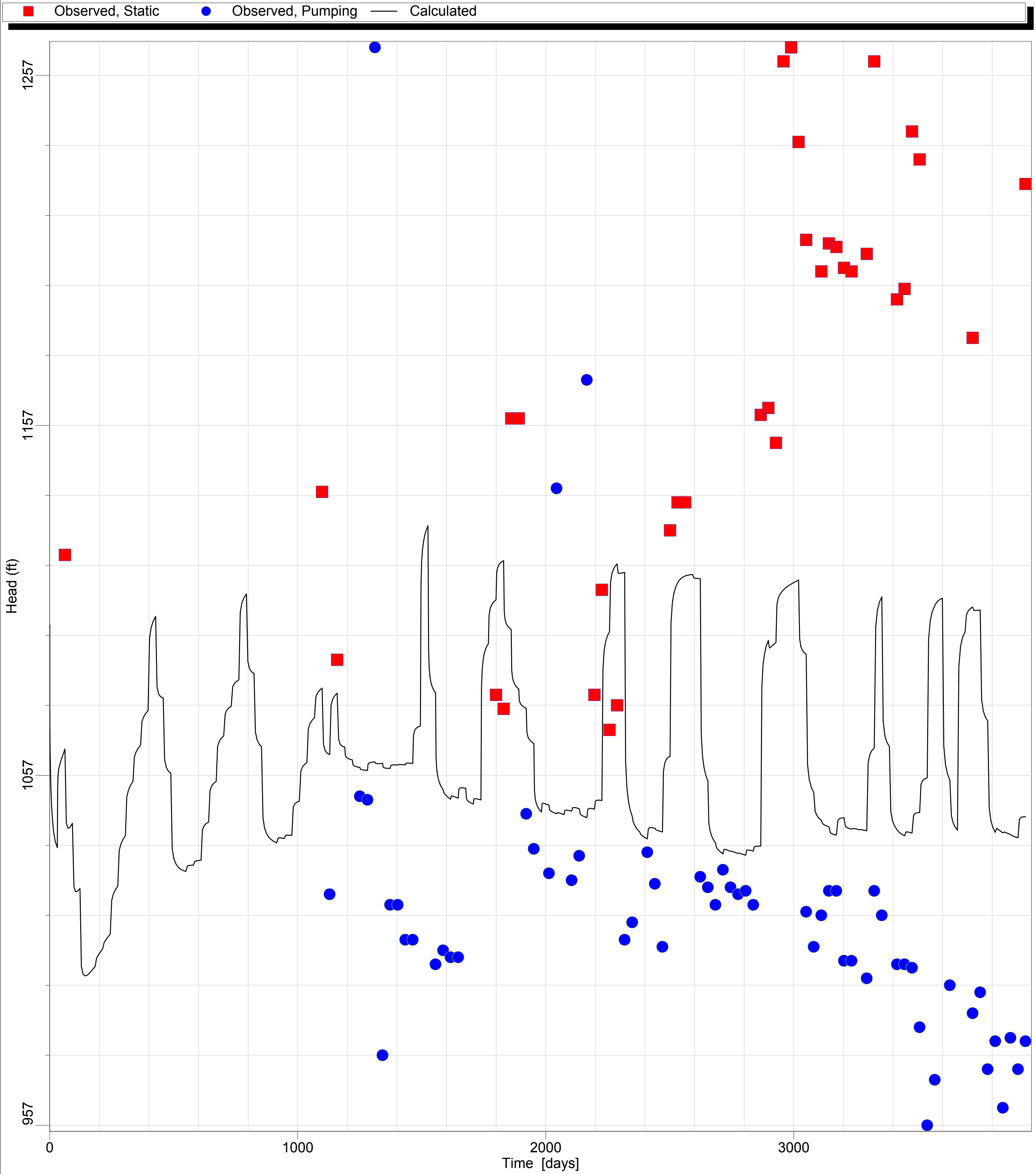
ELSINORE VALLEY MUNICIPAL WATER DISTRICT
ELSINORE BASIN, CALIFORNIA

STRUCTURAL CONTOUR MAP OF BASE
OF BEDFORD CANYON FORMATION (bcb)

FIGURE C-4

MWH

Figure B-1- Head vs. Time (Lincoln)

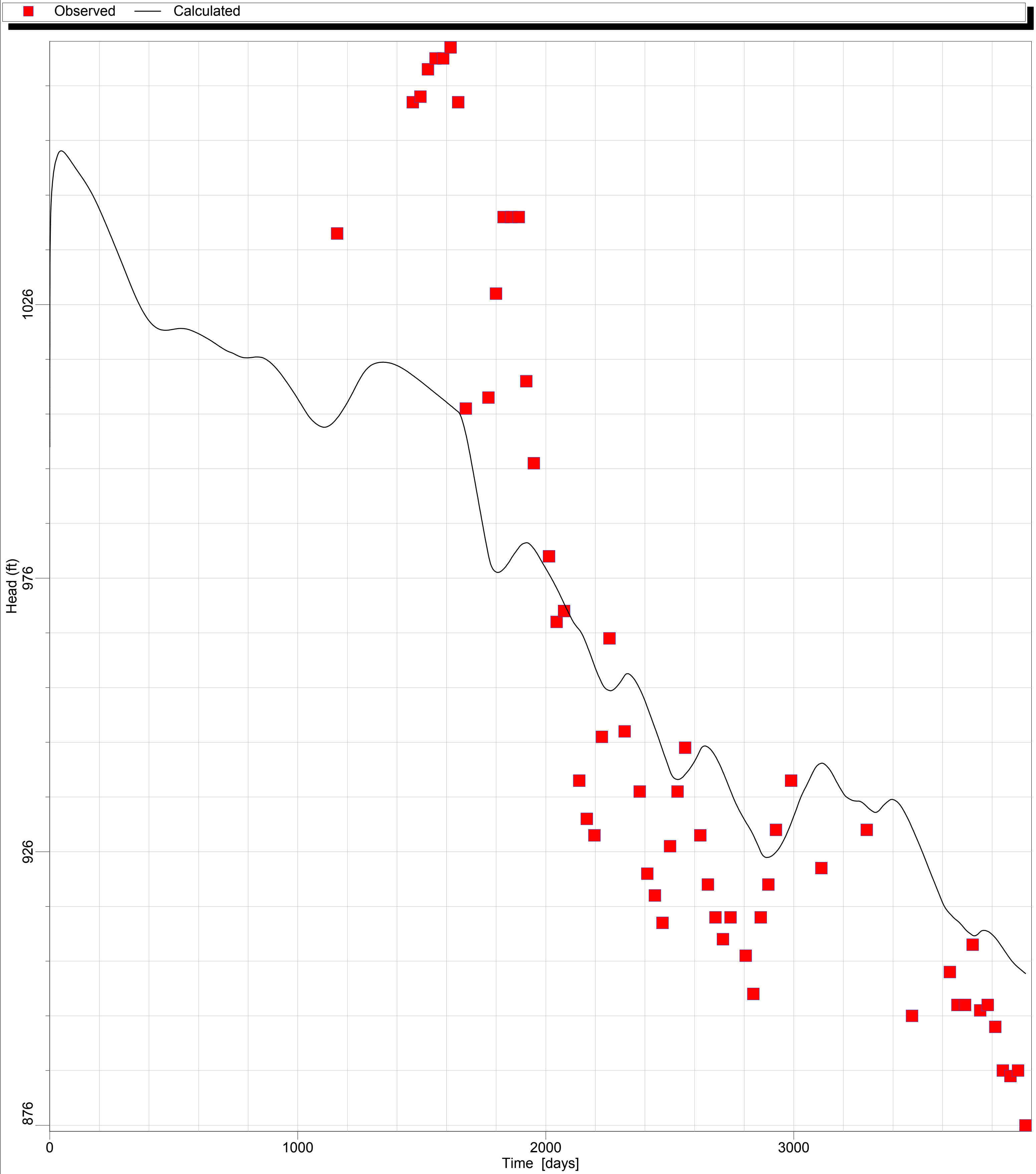


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure B-2- Head vs. Time (North Island)

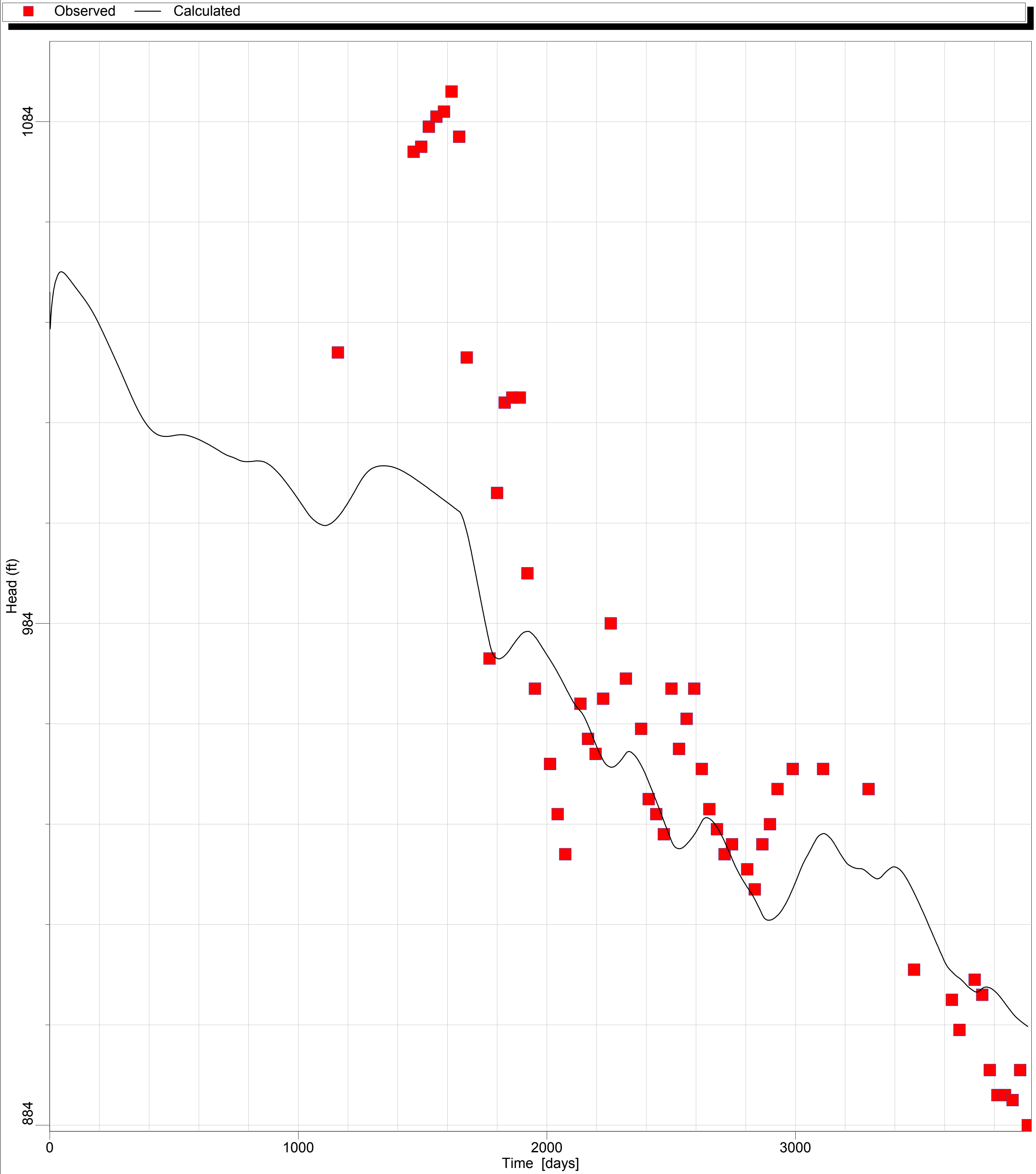


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure B-3- Head vs. Time (South Island)

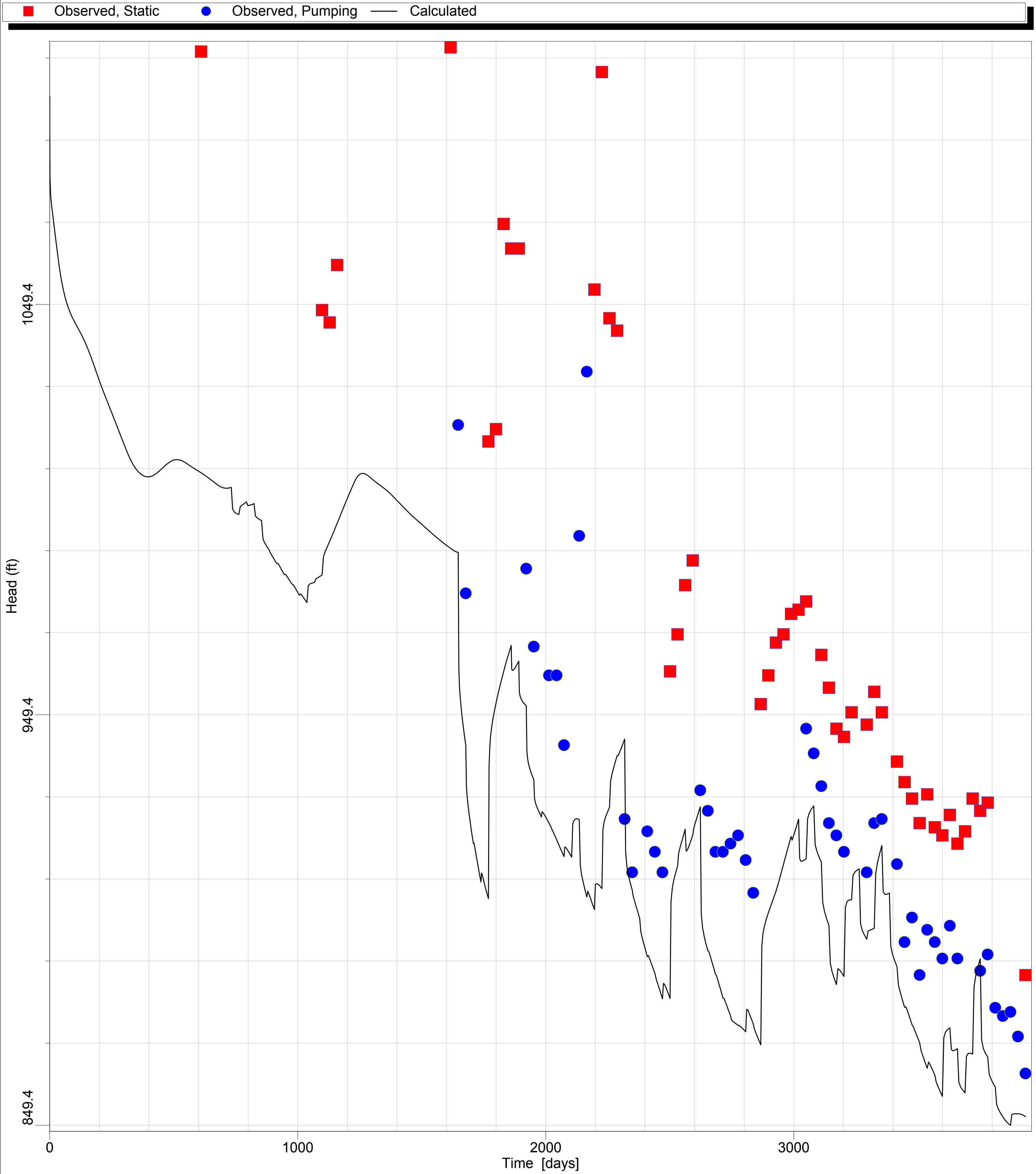


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure B-4- Head vs. Time (Cereal 4)

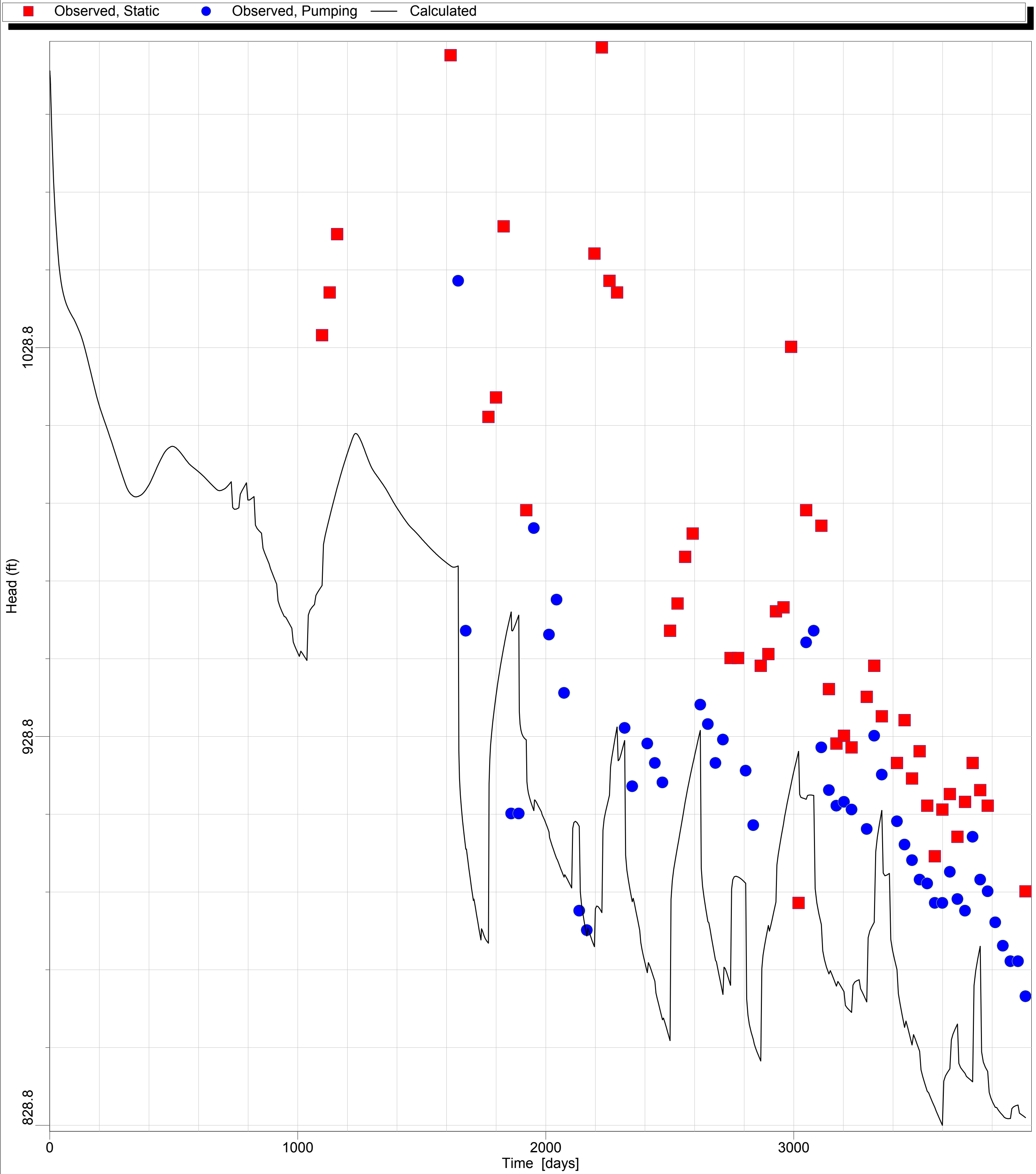


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure B-5- Head vs. Time (Cereal 3)

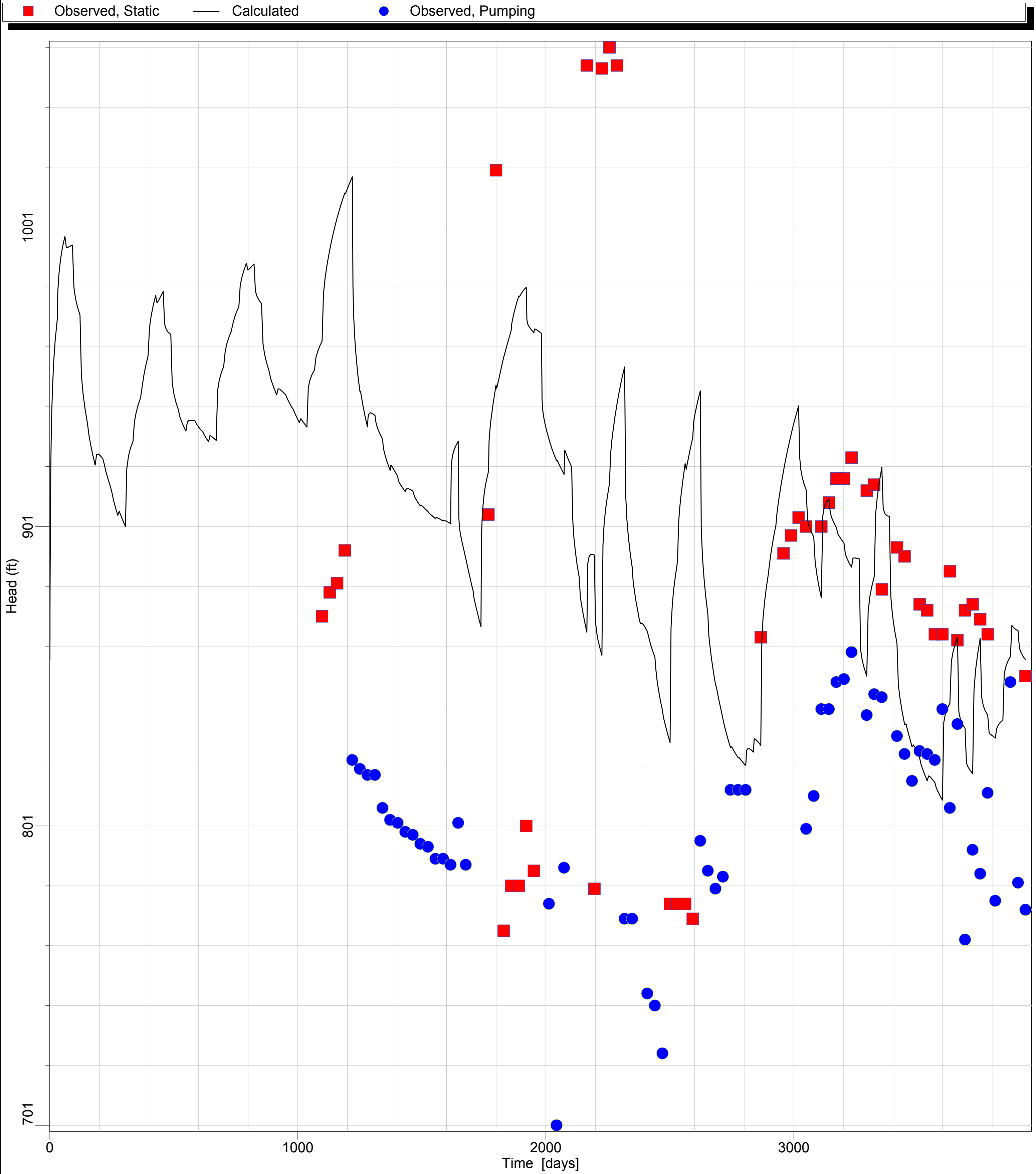


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure B-6- Head vs. Time (Cereal 1)

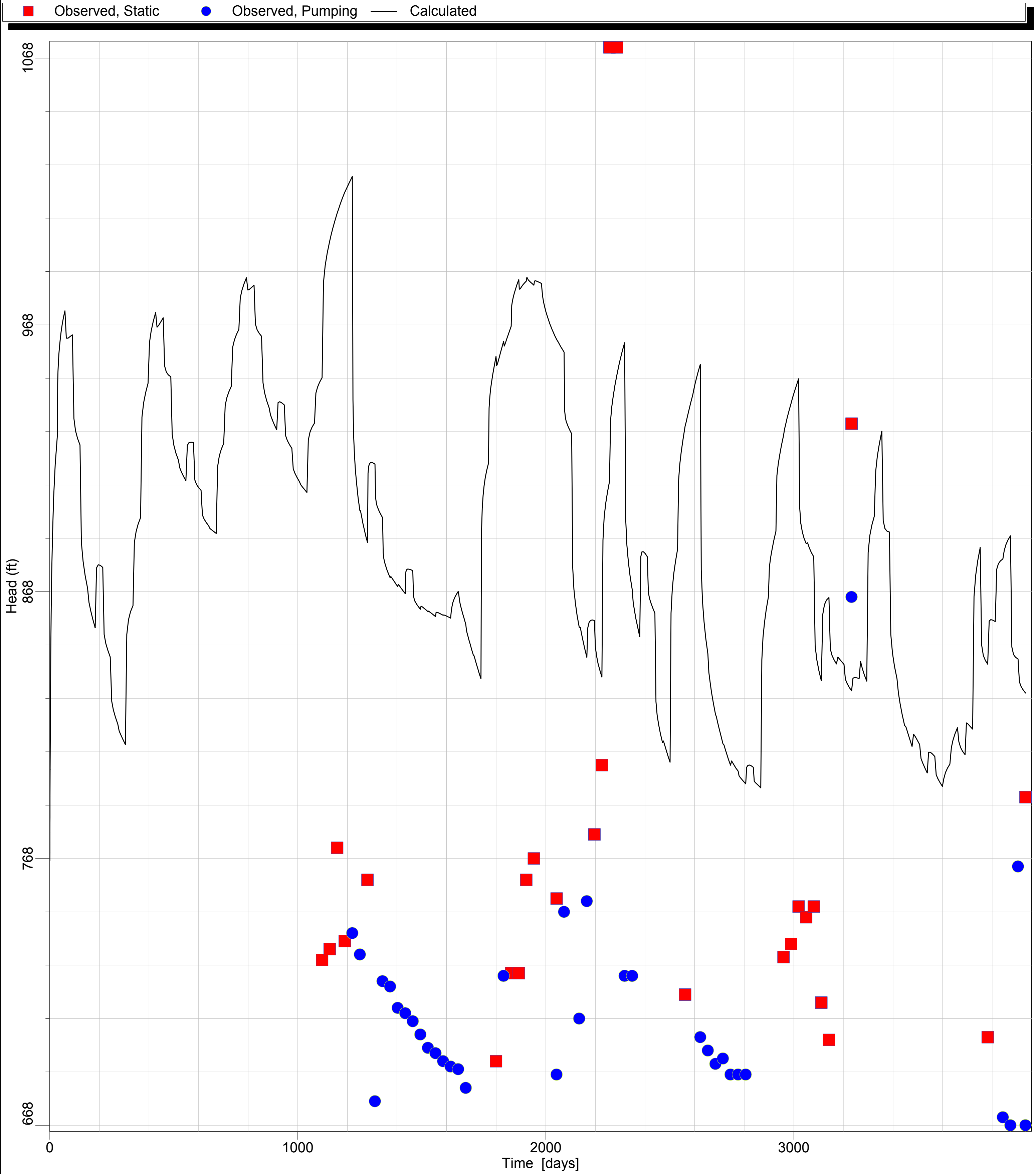


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

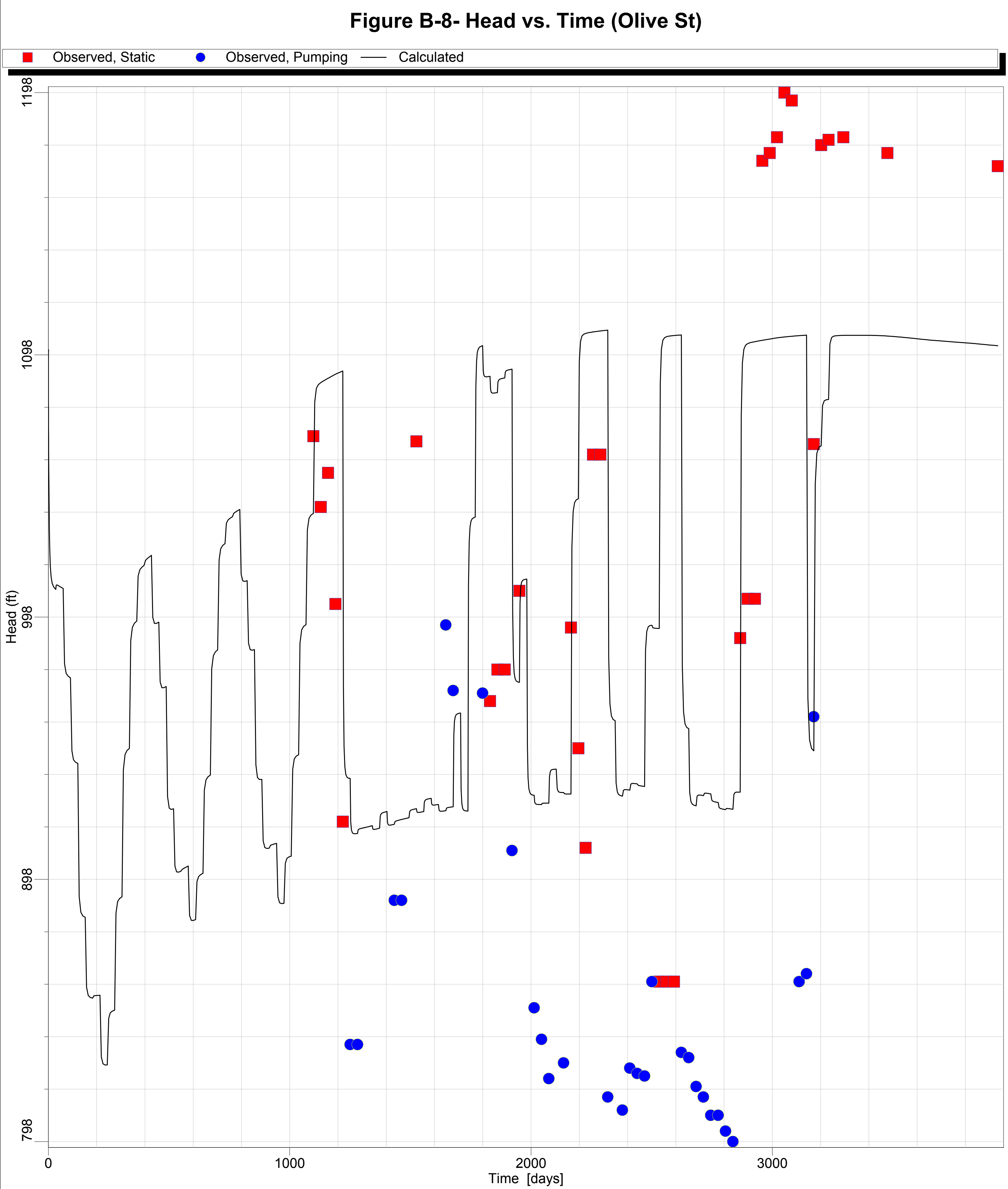
Figure B-7- Head vs. Time (Corydon)



EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

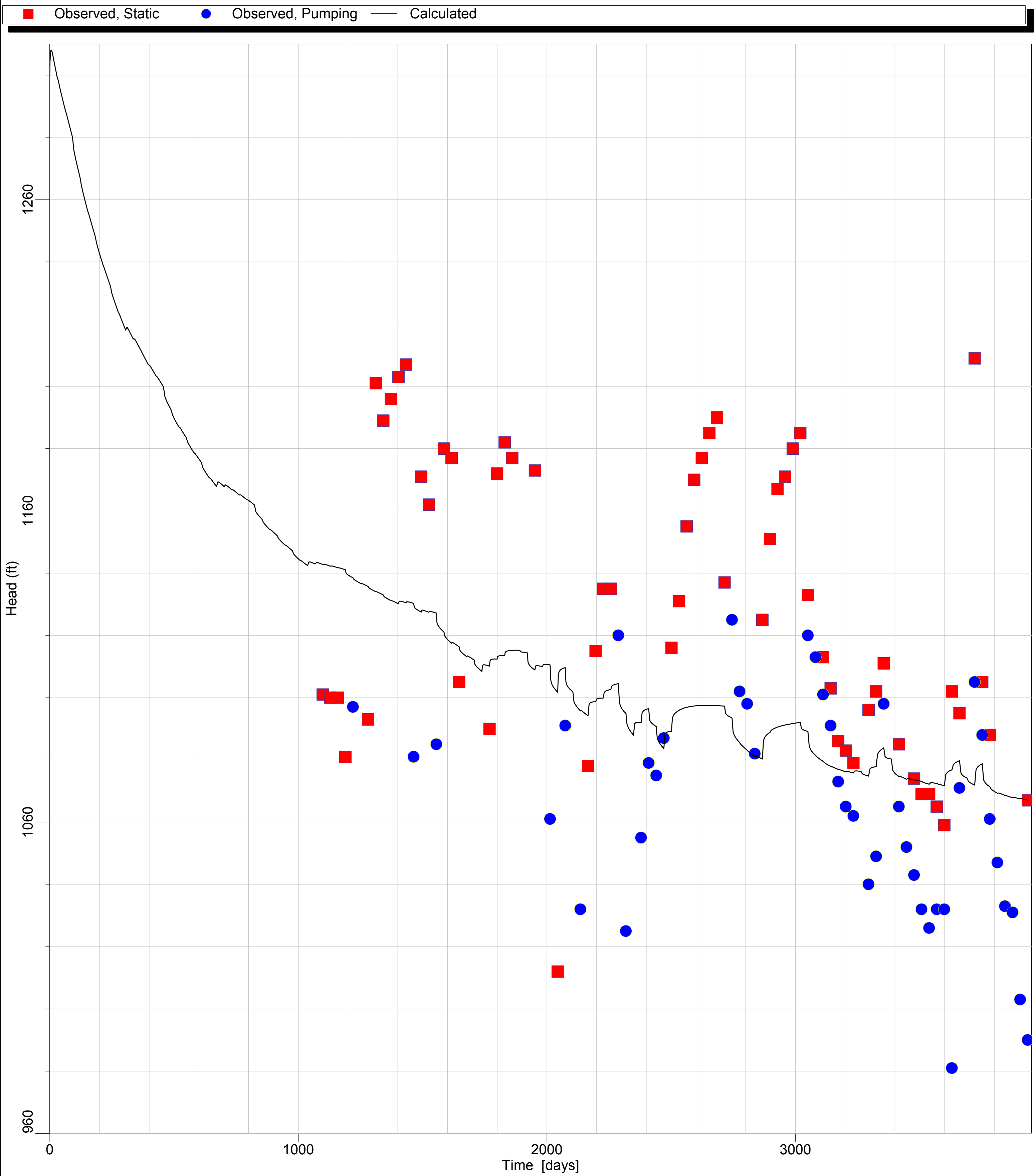


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

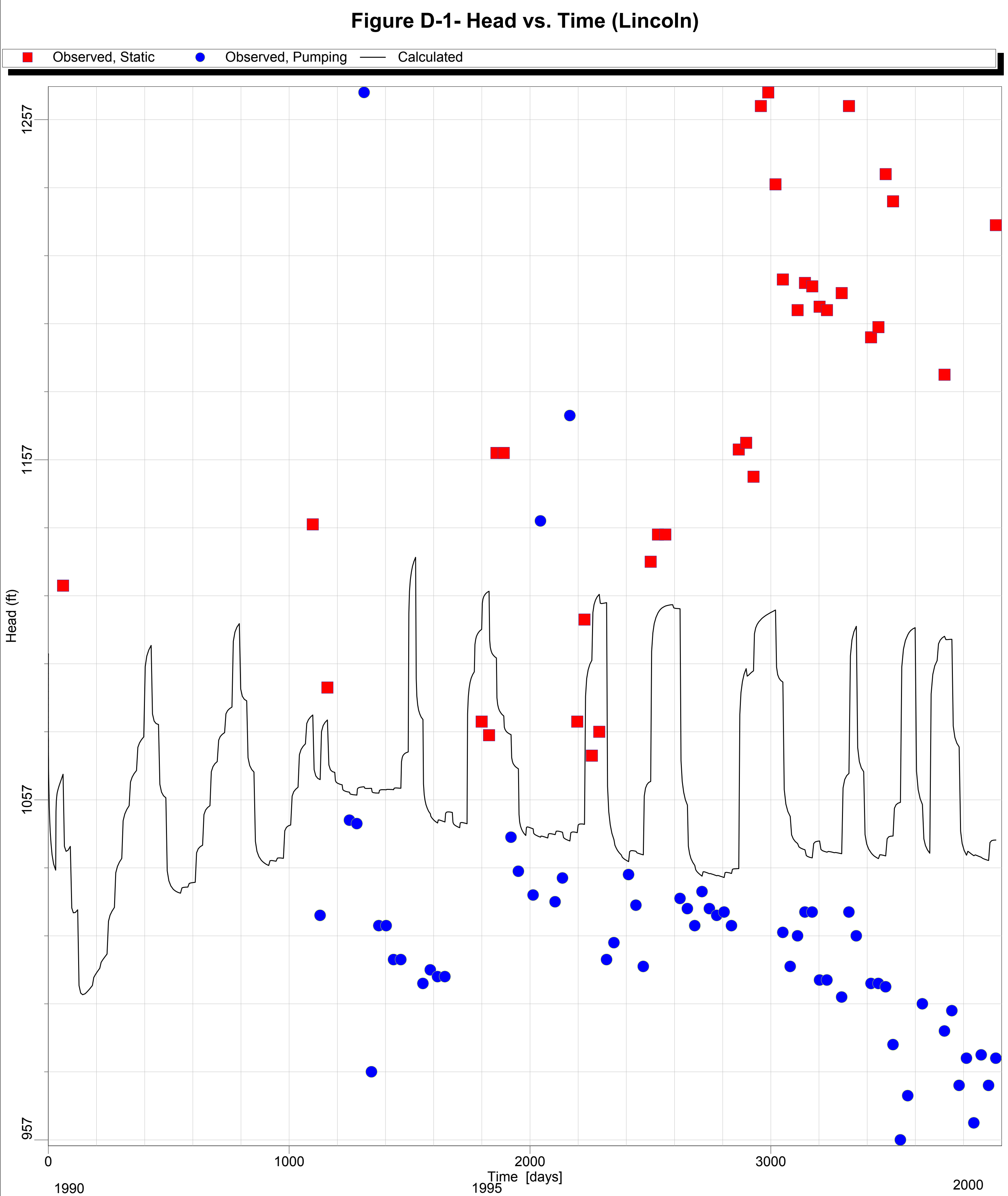
Figure B-9- Head vs. Time (Palomar)



EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

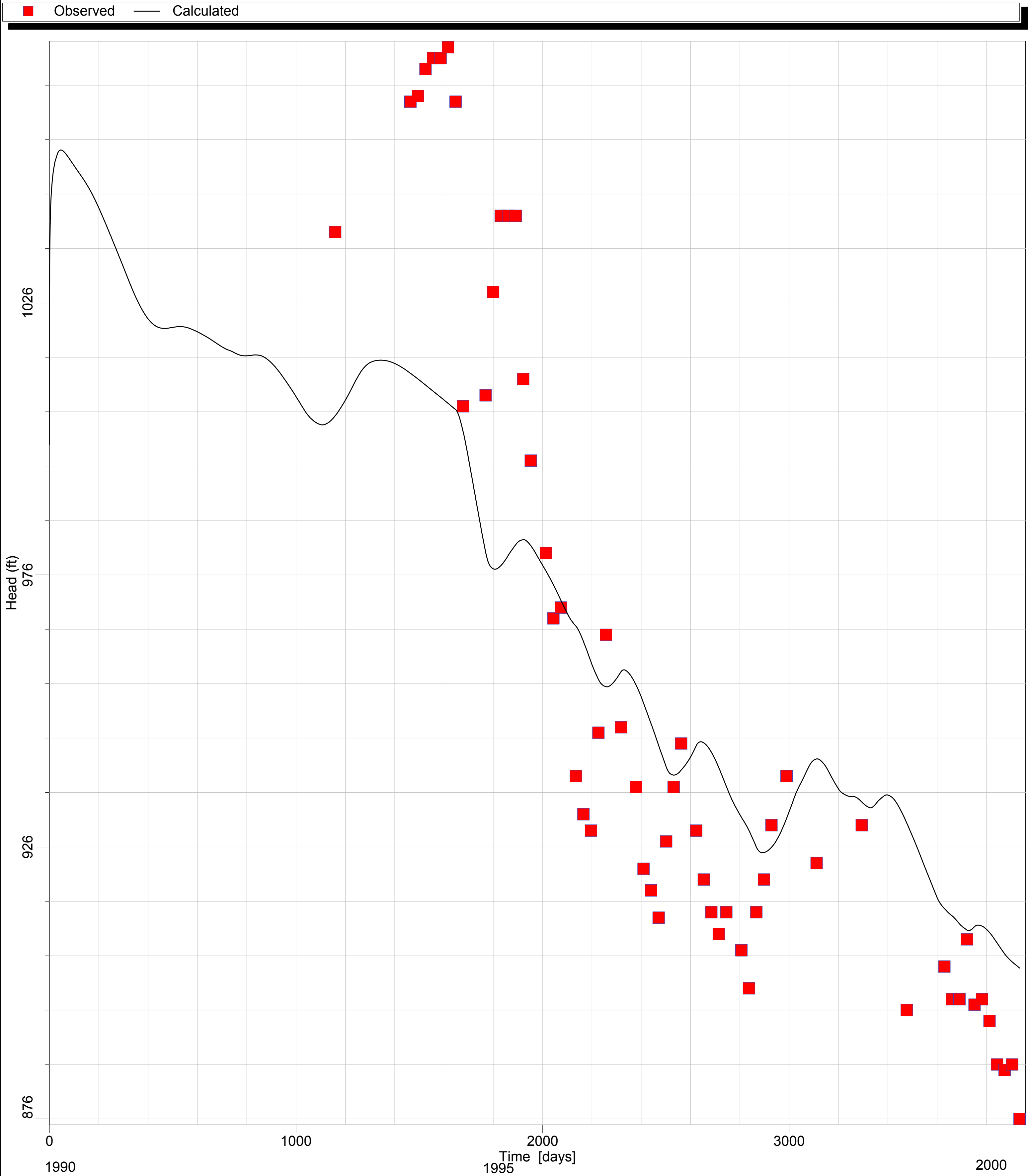


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure D-2- Head vs. Time (North Island)

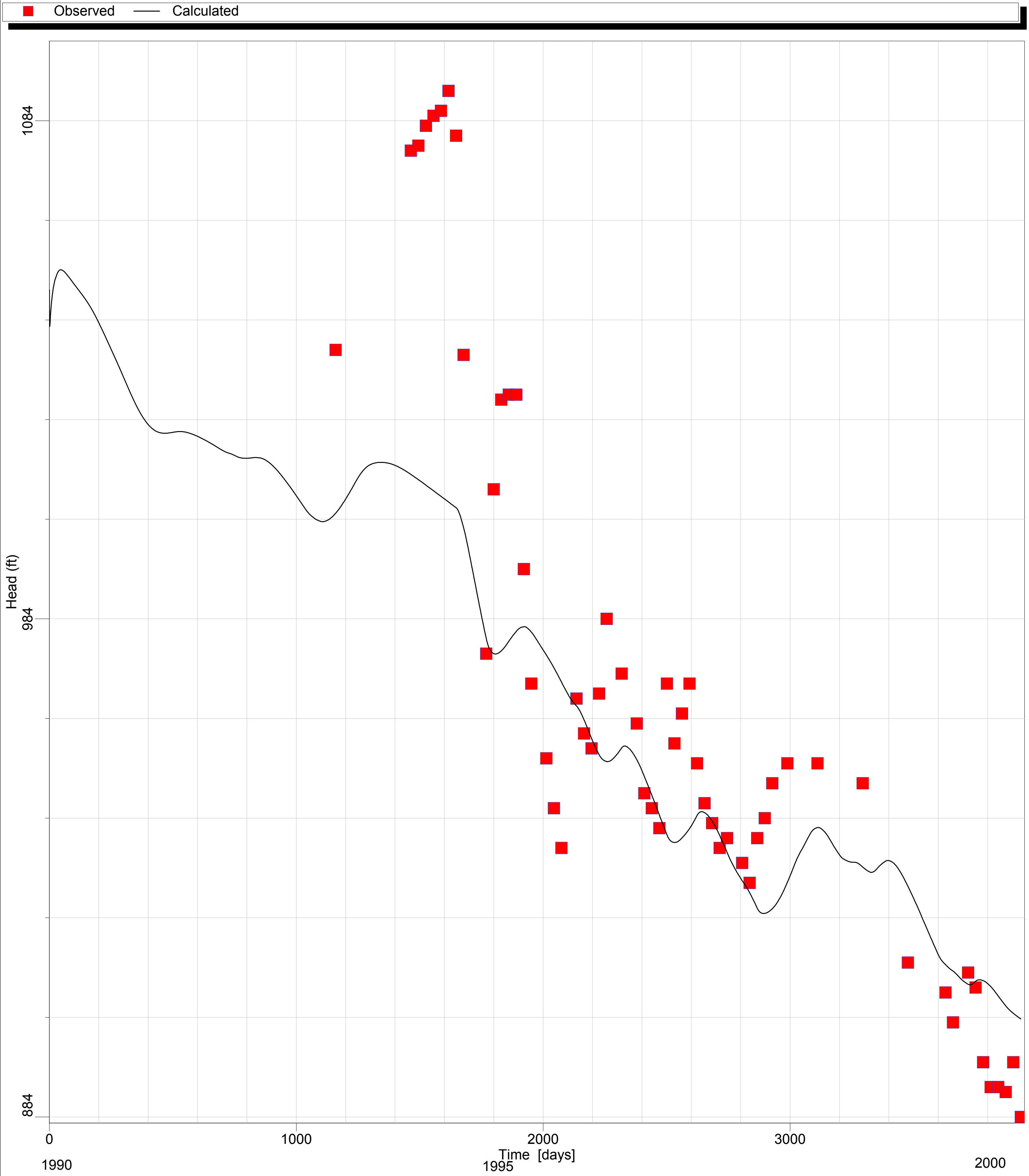


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure D-3- Head vs. Time (South Island)

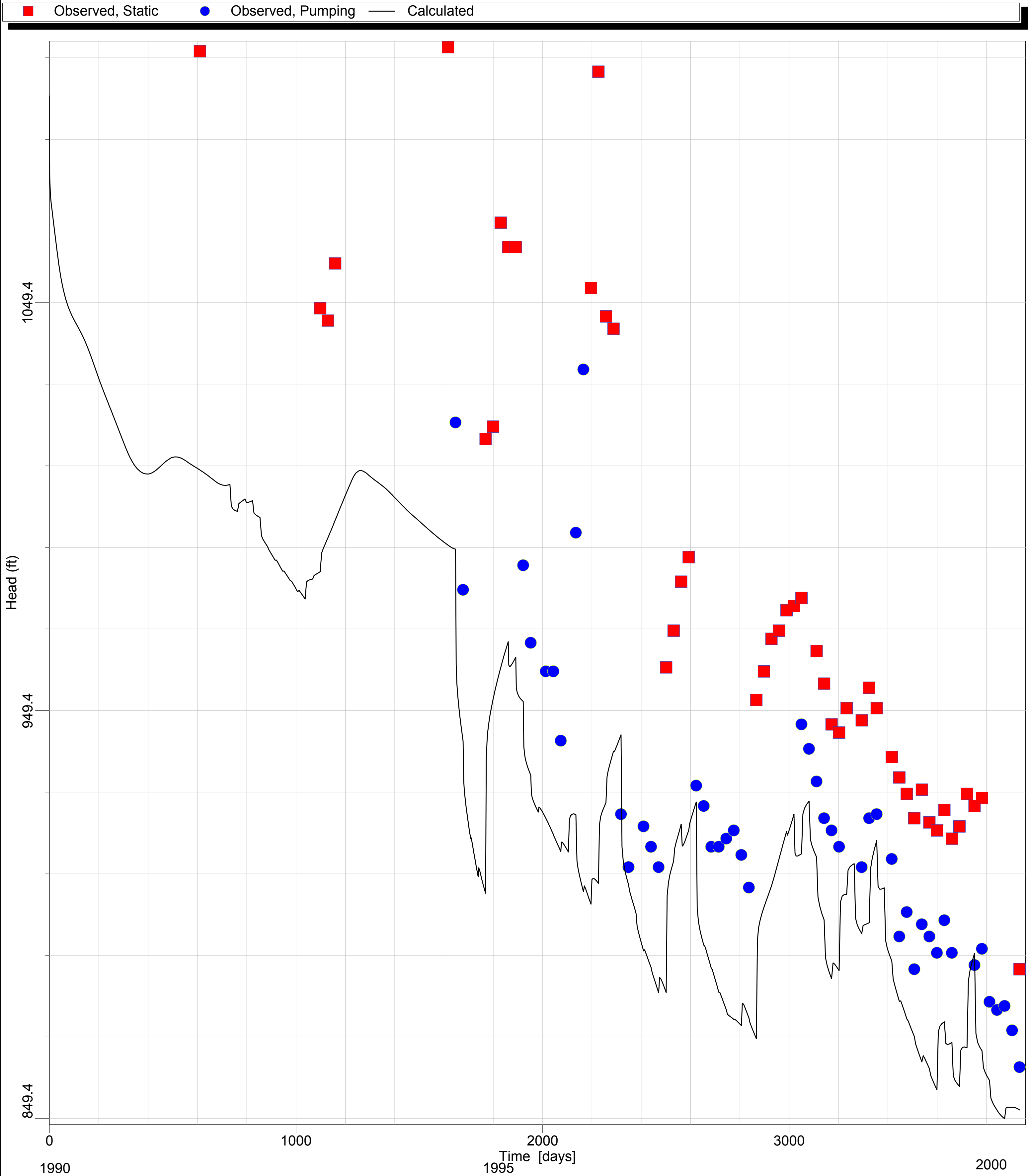


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure D-4- Head vs. Time (Cereal 4)

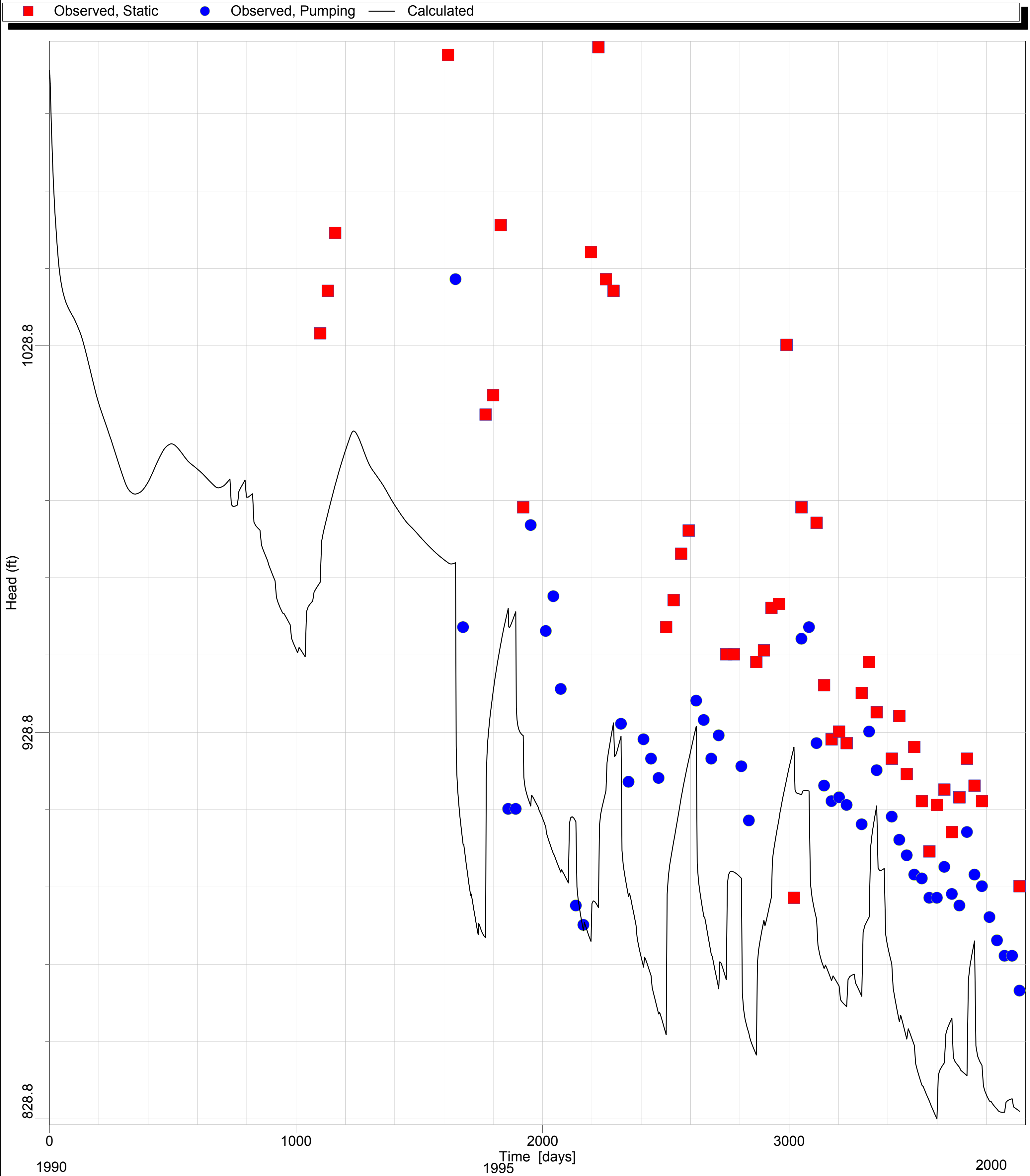


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure D-5- Head vs. Time (Cereal 3)

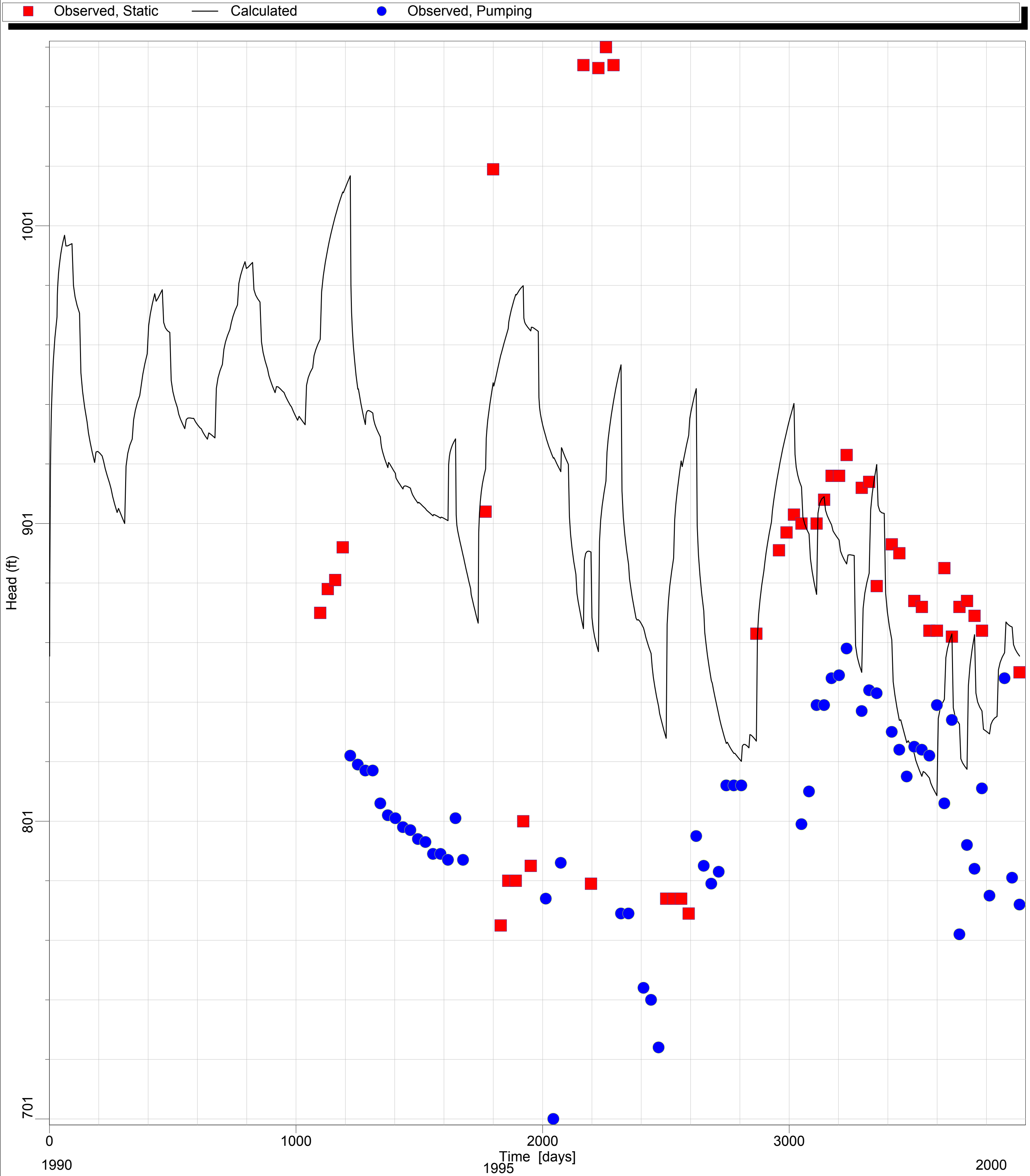


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure D-6- Head vs. Time (Cereal 1)

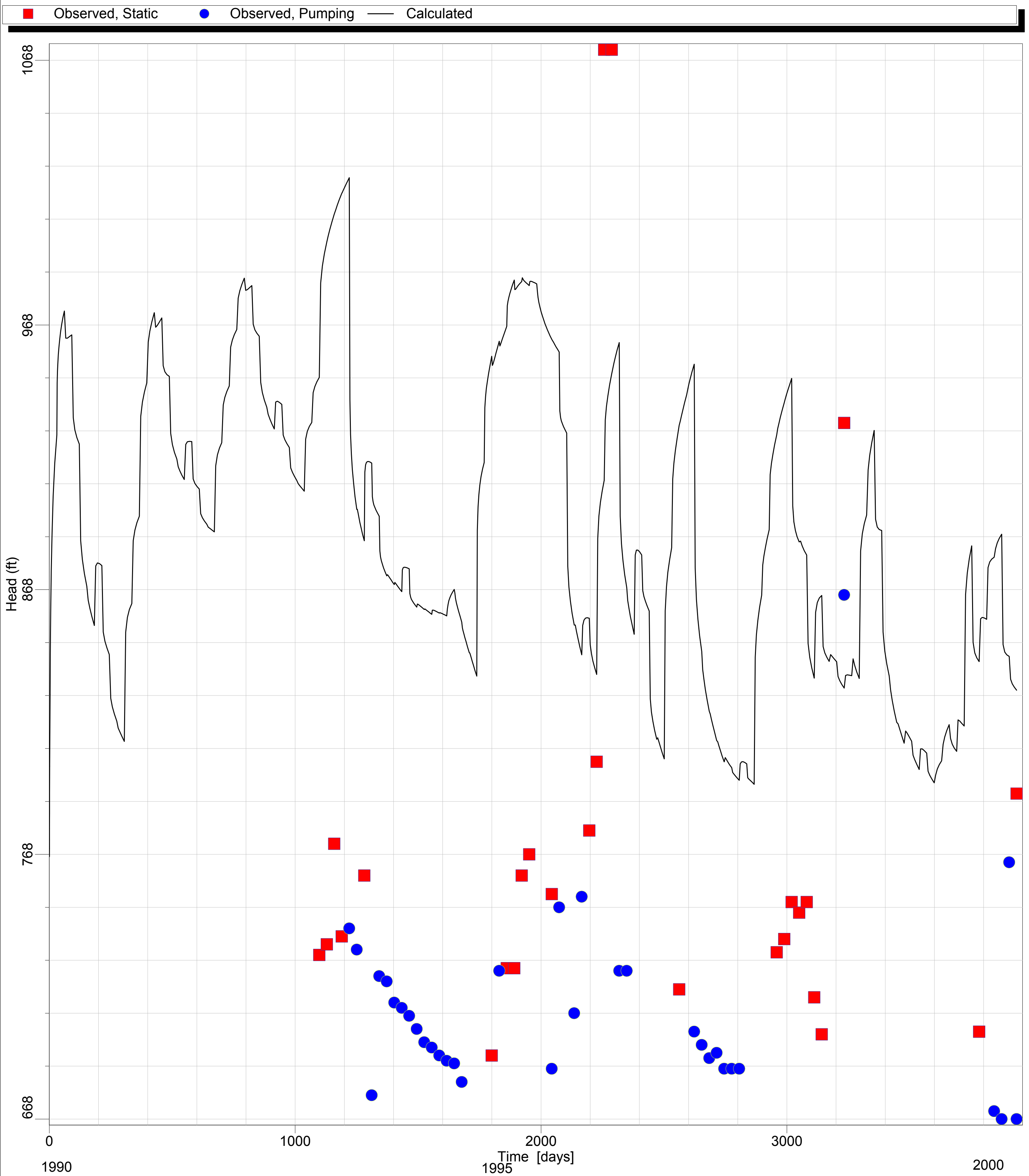


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure D-7- Head vs. Time (Corydon)

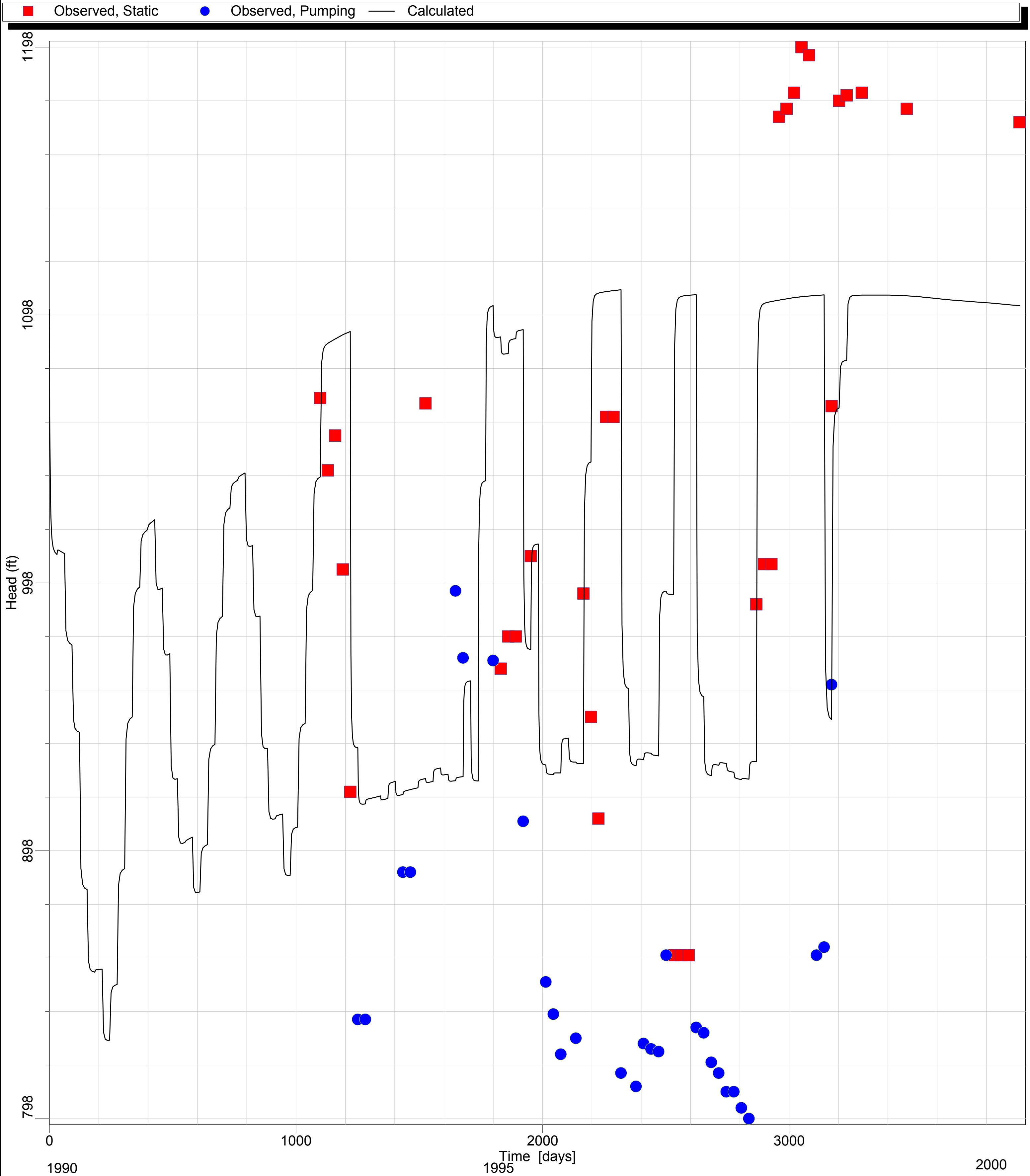


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure D-8- Head vs. Time (Olive St)

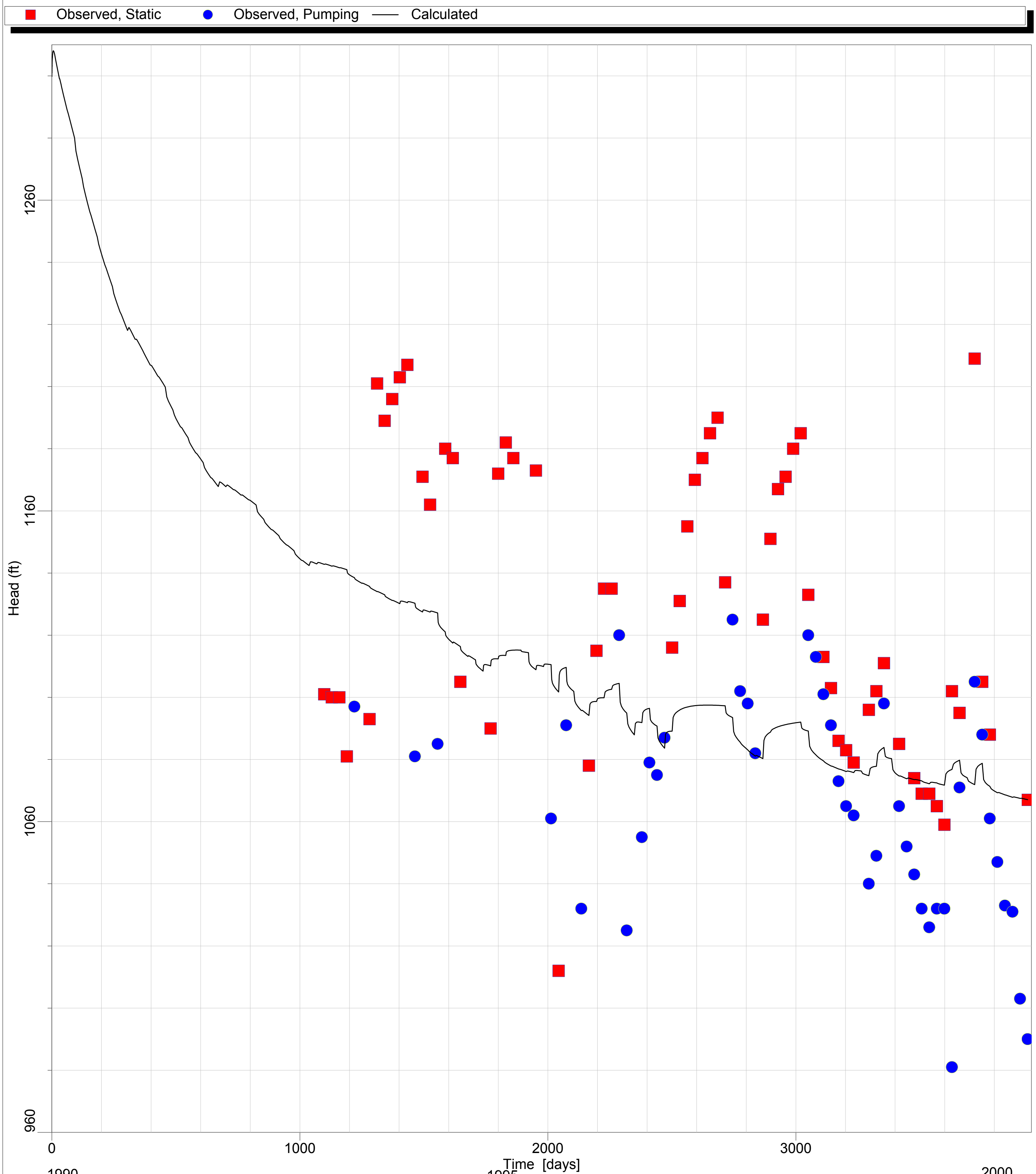


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure D-9- Head vs. Time (Palomar)

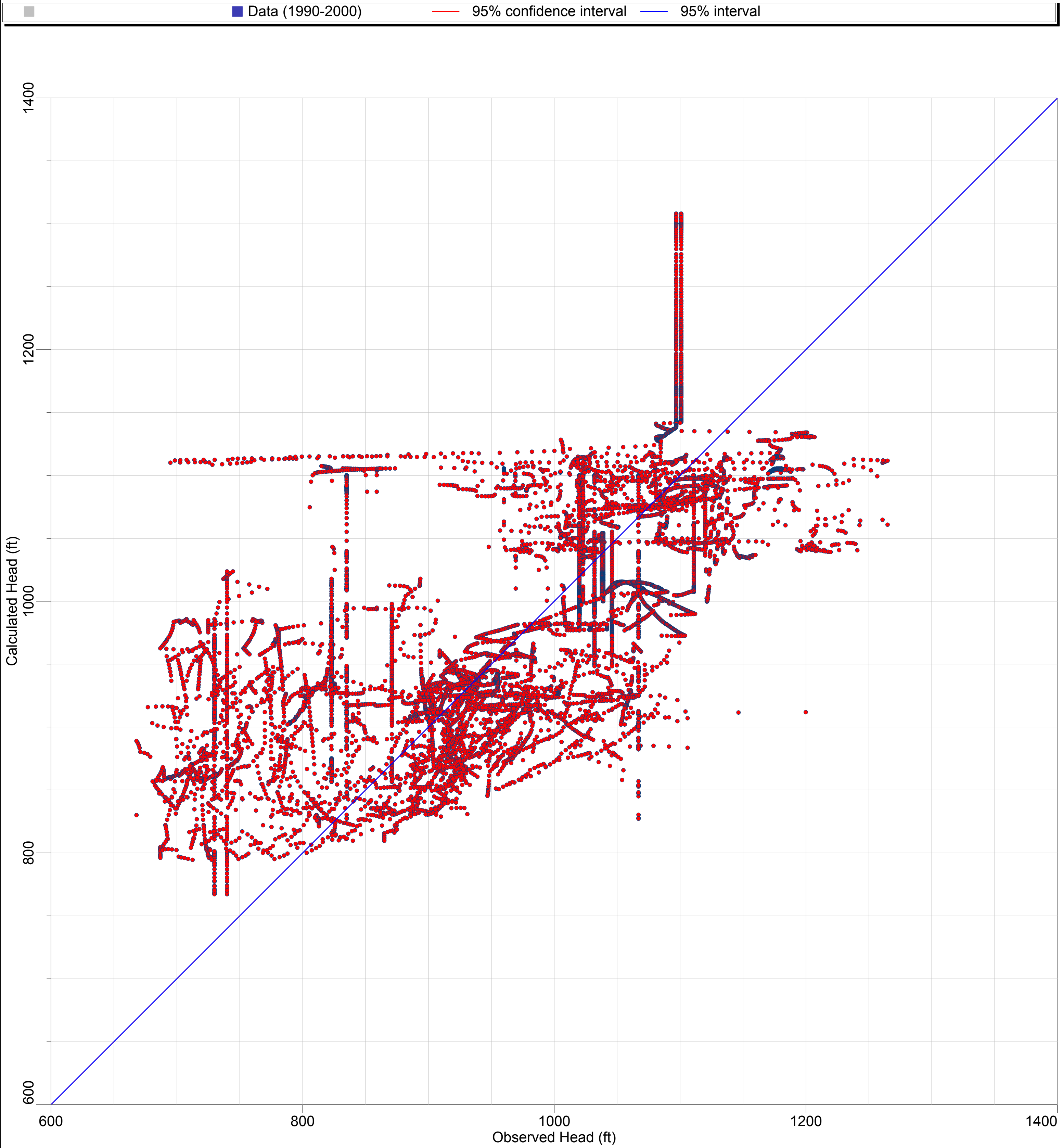


EVWMD
T(0)=January 1990

MWH

Project: Elsinore Basin
Modeller: MWH

Figure D-10 - Model Calibration (1990-2000)

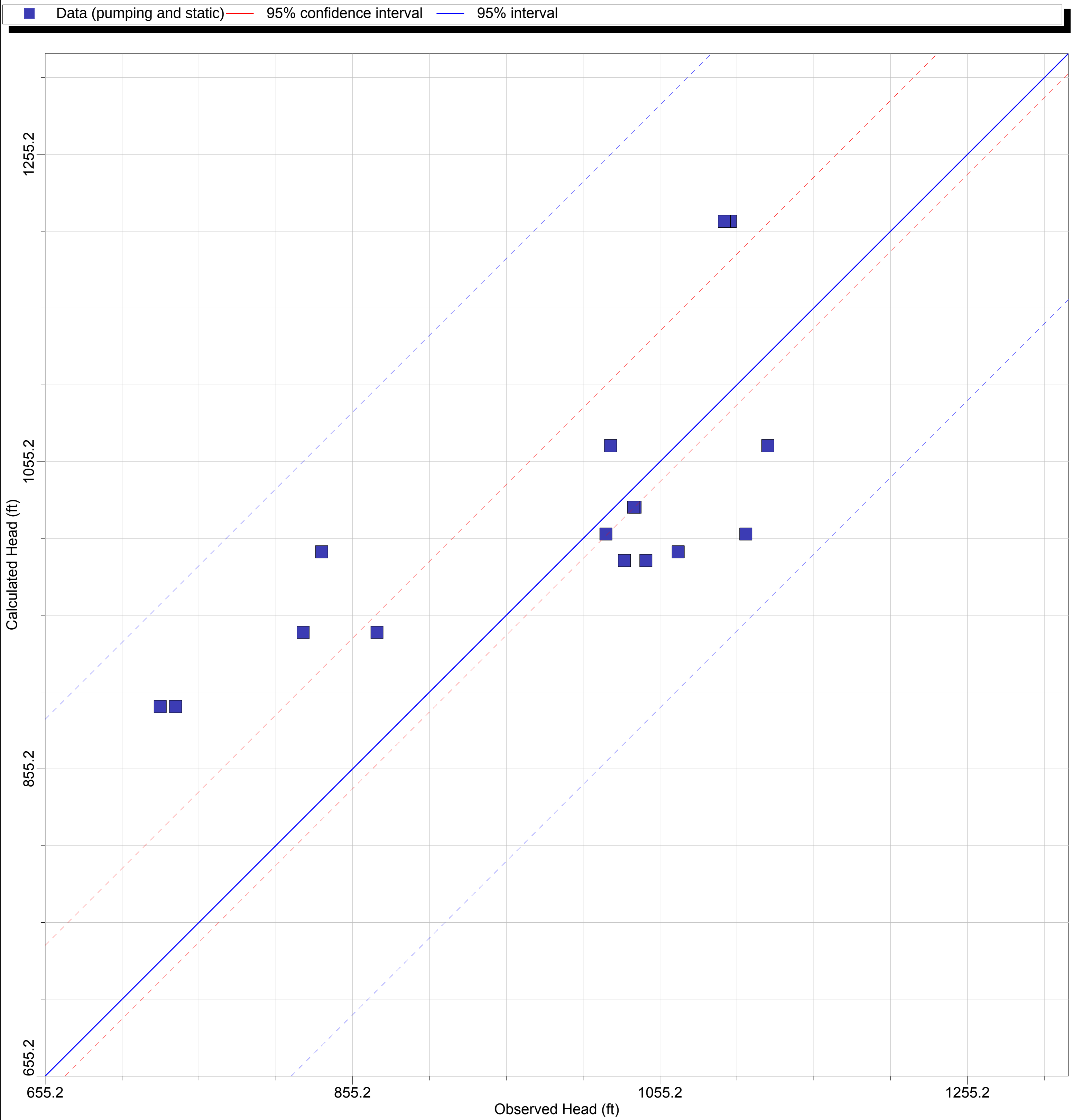


T(0)=January 1990
All static and pumping heads shown.

MWH

Project: Elsinore Basin
Modeller: cdd

Figure D-11 - Model Calibration (January 1991)



Num.Points : 16
Max. Residual: 165.7774 (ft) at Cory/Cory
Min. Residual: -11.89063 (ft) at C_4p/C_4p
Residual Mean : 36.1099 (ft)
Absolute Residual Mean : 82.01377 (ft)

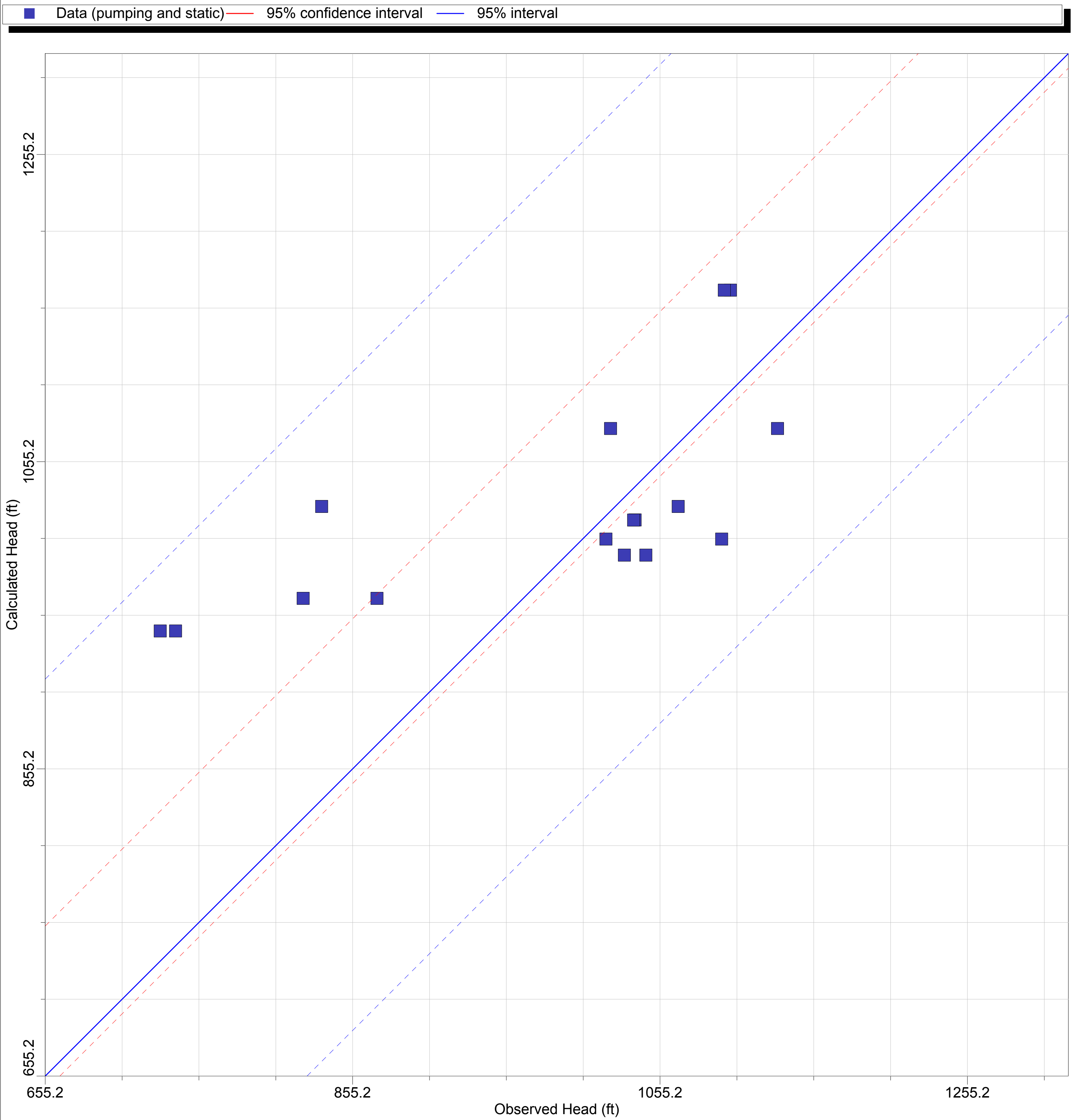
Standard Error of the Estimate : 23.13704 (ft)
Root mean squared : 96.61141 (ft)
Normalized RMS : 24.44039 (%)
Correlation coefficient : 0.7245784

T(0)=January 1990
Time Shown: 366 days (January 1991)

MWH

Project: Elsinore Basin
Modeller: cdd

Figure D-12 - Model Calibration (January 1992)



Num.Points : 16
Max. Residual: 214.9662 (ft) at Cory/Cory
Min. Residual: -15.19879 (ft) at C_4p/C_4p
Residual Mean : 44.08617 (ft)
Absolute Residual Mean : 85.76492 (ft)

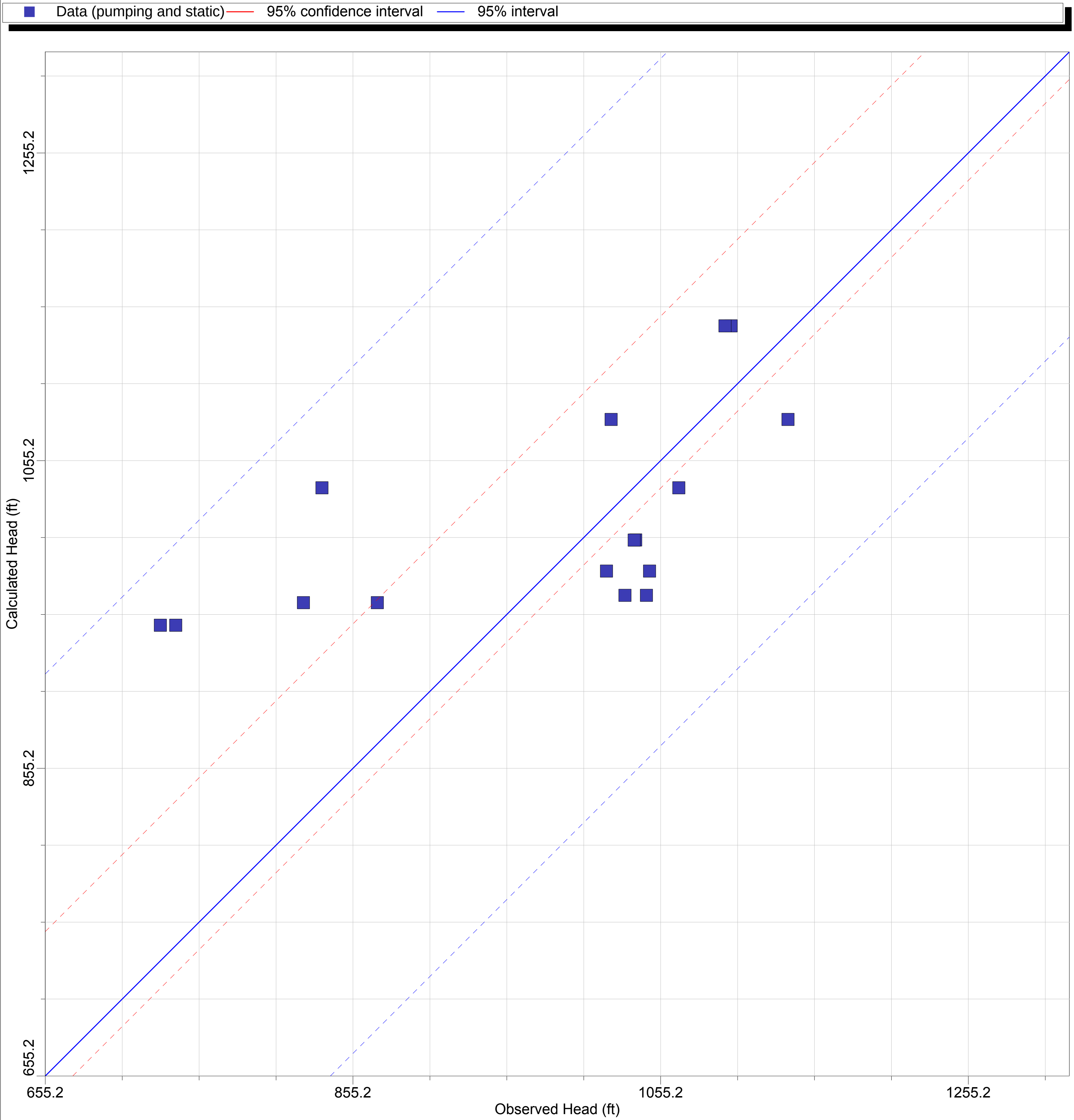
Standard Error of the Estimate : 25.28128 (ft)
Root mean squared : 107.3813 (ft)
Normalized RMS : 26.73523 (%)
Correlation coefficient : 0.6741636

T(0)=January 1990
Time Shown: 732 days (January 1992)

MWH

Project: Elsinore Basin
Modeller: cdd

Figure D-13 - Model Calibration (January 1993)



Num.Points : 16
Max. Residual: 218.2281 (ft) at Cory/Cory
Min. Residual: -29.44702 (ft) at O/O
Residual Mean : 38.01263 (ft)
Absolute Residual Mean : 87.90433 (ft)

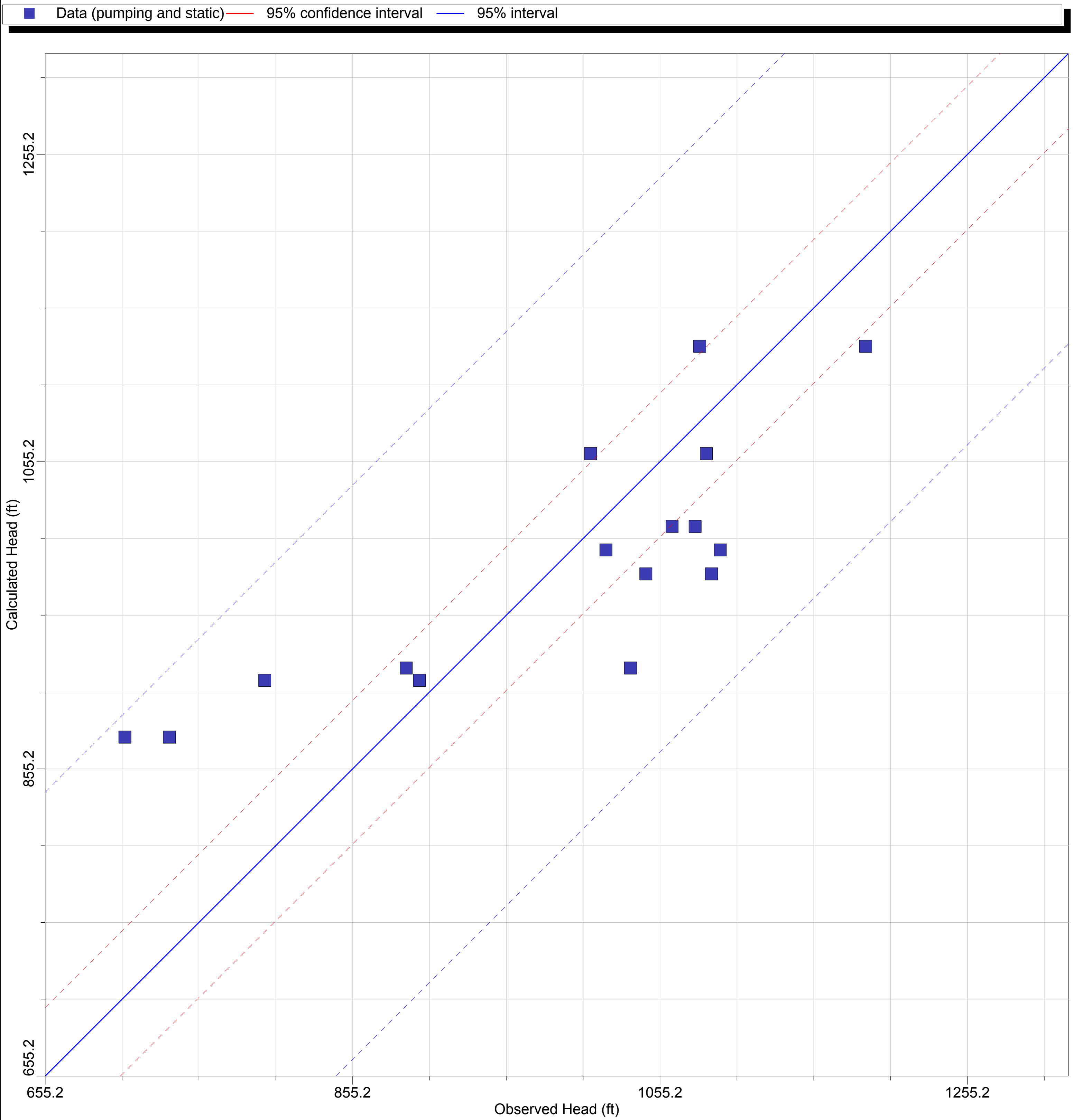
Standard Error of the Estimate : 26.33583 (ft)
Root mean squared : 108.8513 (ft)
Normalized RMS : 26.67923 (%)
Correlation coefficient : 0.612077

T(0)=January 1990
Time Shown: 1098 days (January 1993)

MWH

Project: Elsinore Basin
Modeller: cdd

Figure D-14 - Model Calibration (January 1994)



Num.Points : 16
Max. Residual: 168.864 (ft) at Cory_p/Cory_p
Min. Residual: 14.19927 (ft) at C_1/C_1
Residual Mean : -2.170574 (ft)
Absolute Residual Mean : 73.2122 (ft)

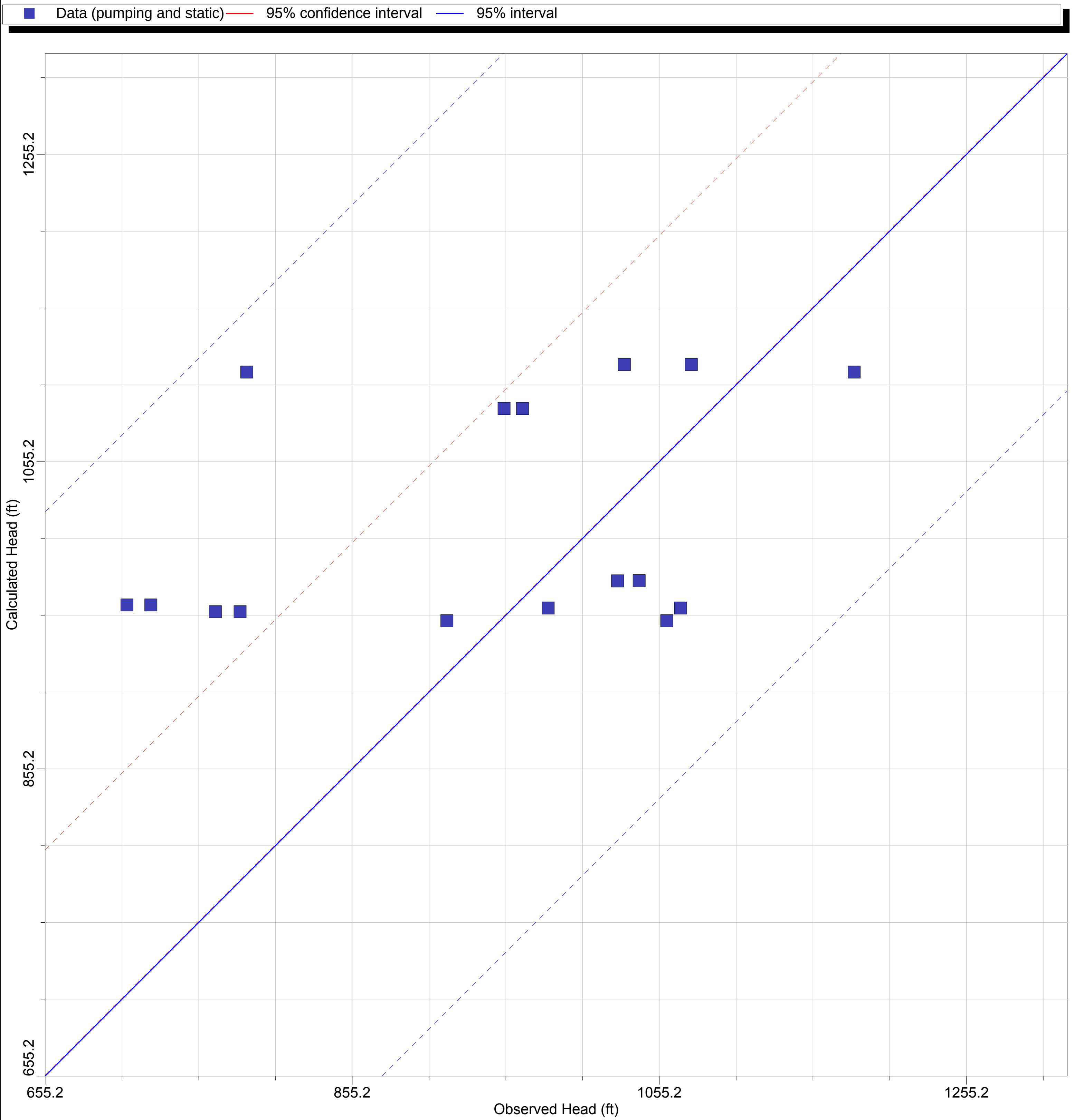
Standard Error of the Estimate : 22.04592 (ft)
Root mean squared : 85.41105 (ft)
Normalized RMS : 17.72014 (%)
Correlation coefficient : 0.8158778

T(0)=January 1990
Time Shown: 1464days (January 1994)

MWH

Project: Elsinore Basin
Modeller: cdd

Figure D-15 - Model Calibration (January 1995)



Num.Points : 16
Max. Residual: 326.995 (ft) at P_p/P_p
Min. Residual: -22.82623 (ft) at C_4p/C_4p
Residual Mean : 74.01883 (ft)
Absolute Residual Mean : 126.9661 (ft)

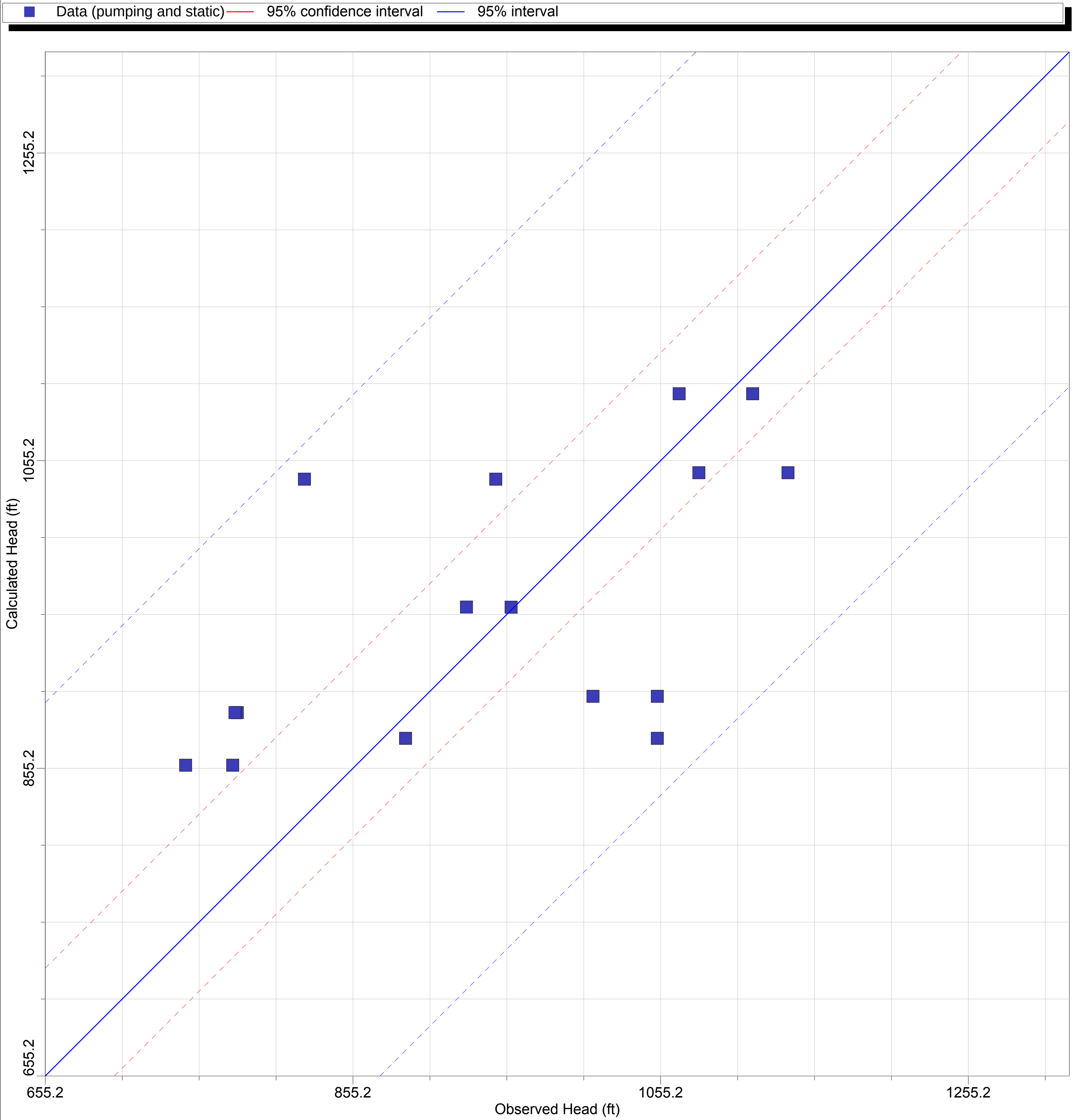
Standard Error of the Estimate : 34.59231 (ft)
Root mean squared : 153.0627 (ft)
Normalized RMS : 32.32582 (%)
Correlation coefficient : 0.3457494

T(0)=January 1990
Time Shown: 1830 days (January 1995)

MWH

Project: Elsinore Basin
Modeller: cdd

Figure D-16 - Model Calibration (January 1996)



Num.Points : 16
Max. Residual: 219.4797 (ft) at O_p/O_p
Min. Residual: 1.971375 (ft) at S_ls/S_ls
Residual Mean : 12.59436 (ft)
Absolute Residual Mean : 86.70548 (ft)

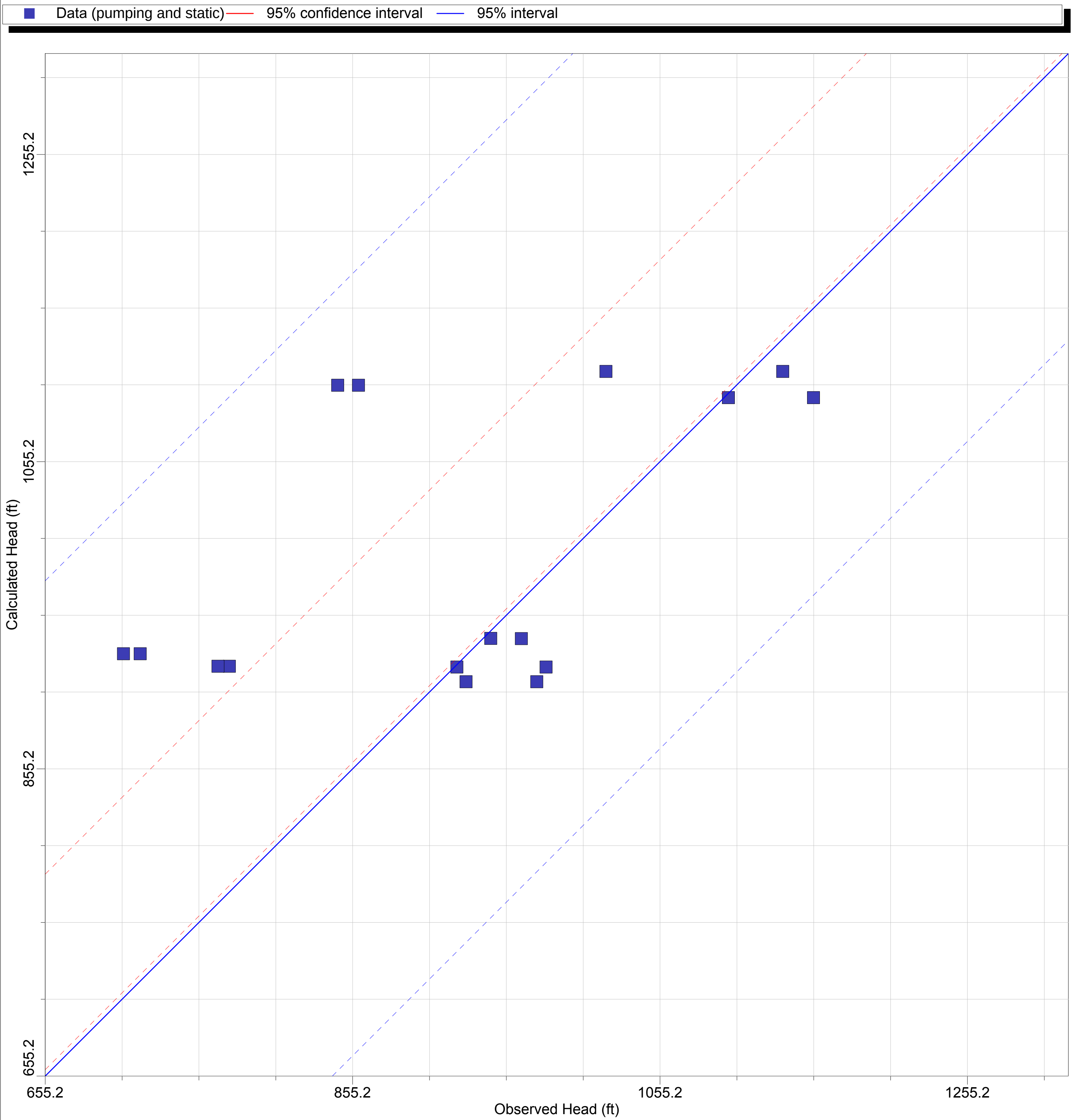
Standard Error of the Estimate : 27.14255 (ft)
Root mean squared : 105.8744 (ft)
Normalized RMS : 27.03636 (%)
Correlation coefficient : 0.5883181

T(0)=January 1990
Time Shown: 2196 days (January 1996)

MWH

Project: Elsinore Basin
Modeller: cdd

Figure D-17 - Model Calibration (January 1997)



Num.Points : 16
Max. Residual: 259.4382 (ft) at O_p/O_p
Min. Residual: -1.482666 (ft) at C_4p/C_4p
Residual Mean : 67.80388 (ft)
Absolute Residual Mean : 99.42454 (ft)

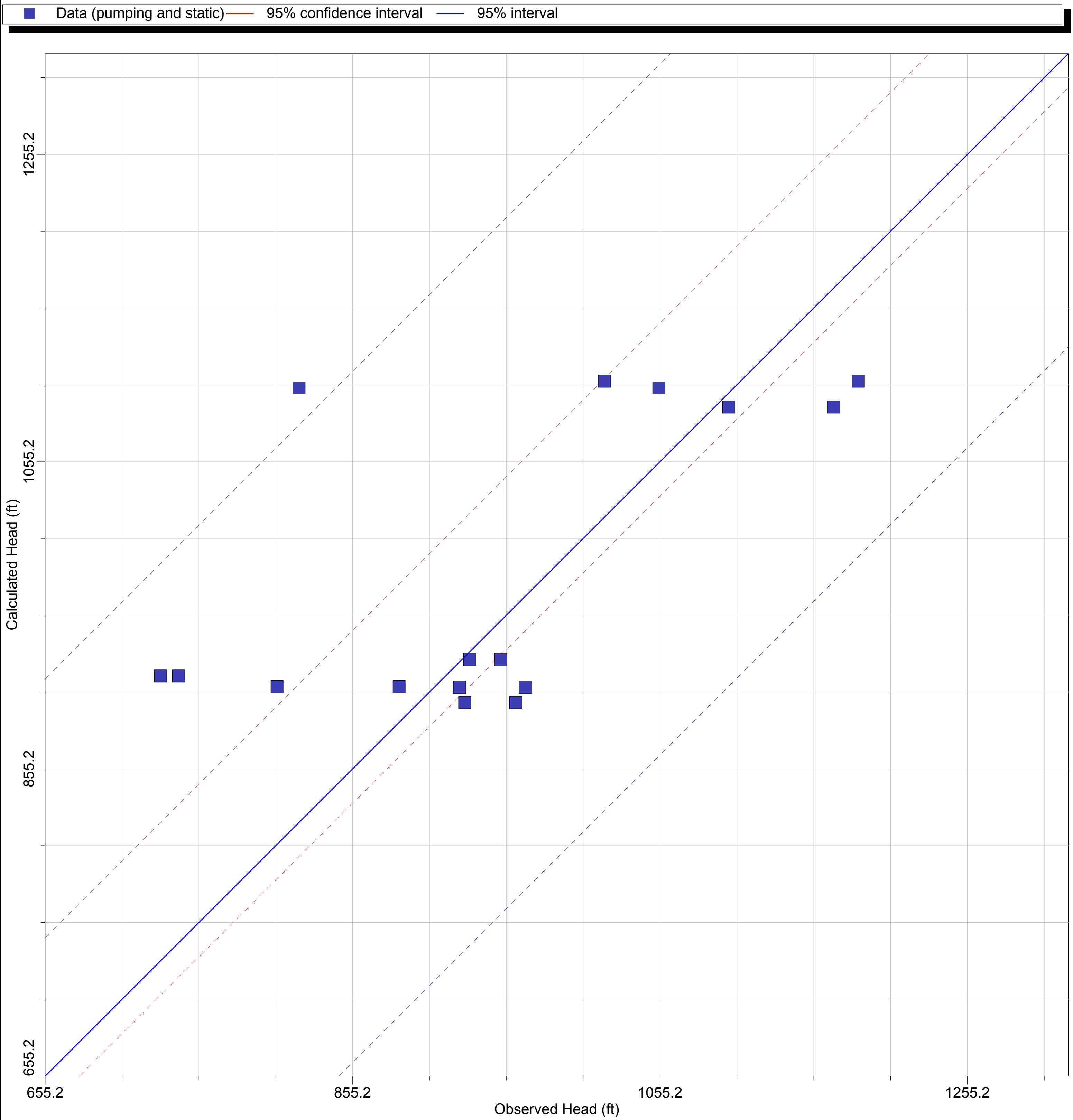
Standard Error of the Estimate : 30.02689 (ft)
Root mean squared : 134.6164 (ft)
Normalized RMS : 29.98881 (%)
Correlation coefficient : 0.526229

T(0)=January 1990
Time Shown: 2562 days (January 1997)

MWH

Project: Elsinore Basin
Modeller: cdd

Figure D-18 - Model Calibration (January 1998)



Num.Points : 16
Max. Residual: 282.868 (ft) at O_p/O_p
Min. Residual: -4.922827 (ft) at N_ls/N_ls
Residual Mean : 33.94425 (ft)
Absolute Residual Mean : 79.20999 (ft)

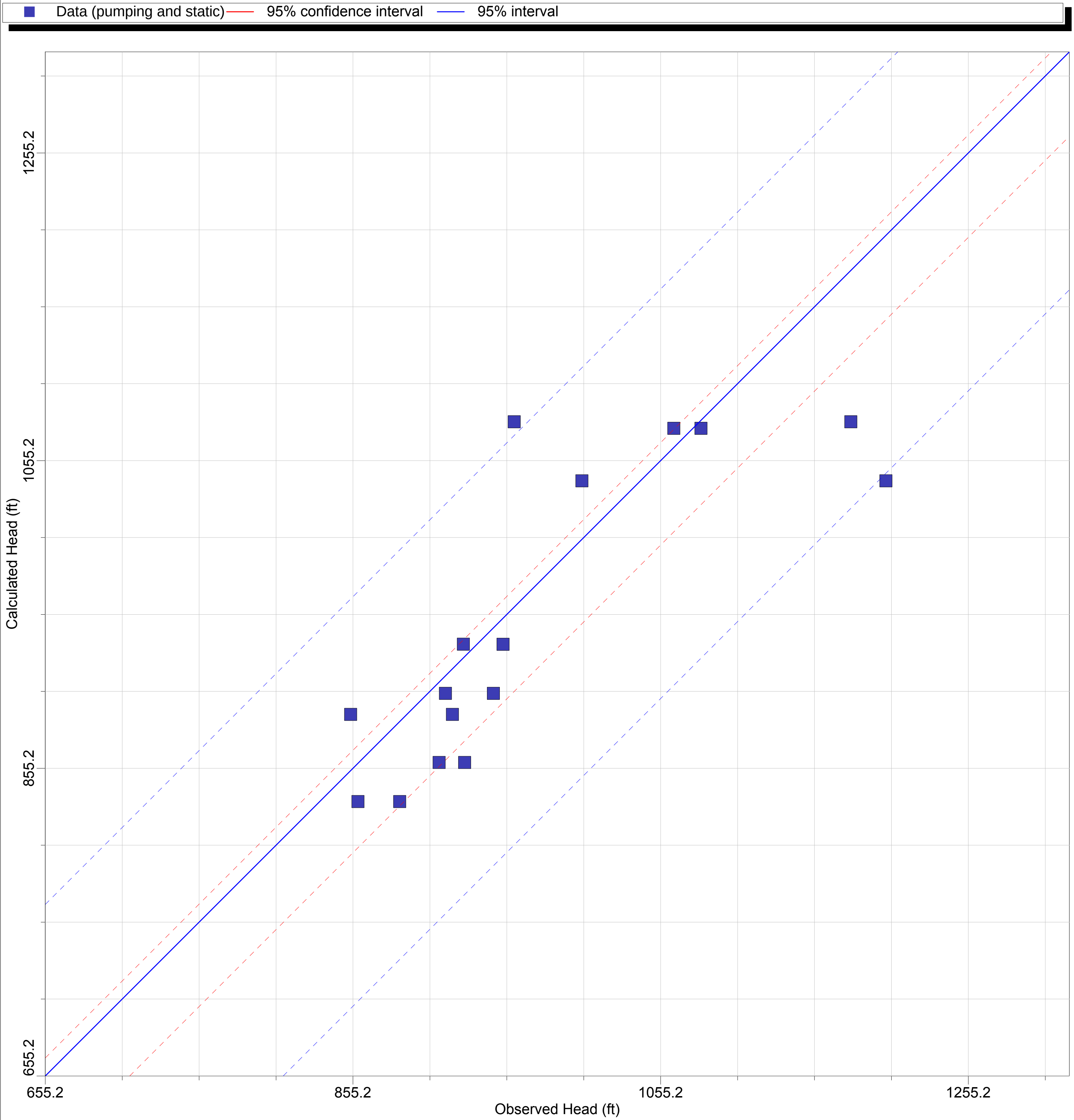
Standard Error of the Estimate : 26.51521 (ft)
Root mean squared : 108.1576 (ft)
Normalized RMS : 23.82415 (%)
Correlation coefficient : 0.627241

T(0)=January 1990
Time Shown: 2937 days (January 1998)

MWH

Project: Elsinore Basin
Modeller: cdd

Figure D-19 - Model Calibration (January 1999)



Num.Points : 16
Max. Residual: -159.5461 (ft) at L/L
Min. Residual: -5.171691 (ft) at P/P
Residual Mean : -21.55193 (ft)
Absolute Residual Mean : 48.60233 (ft)

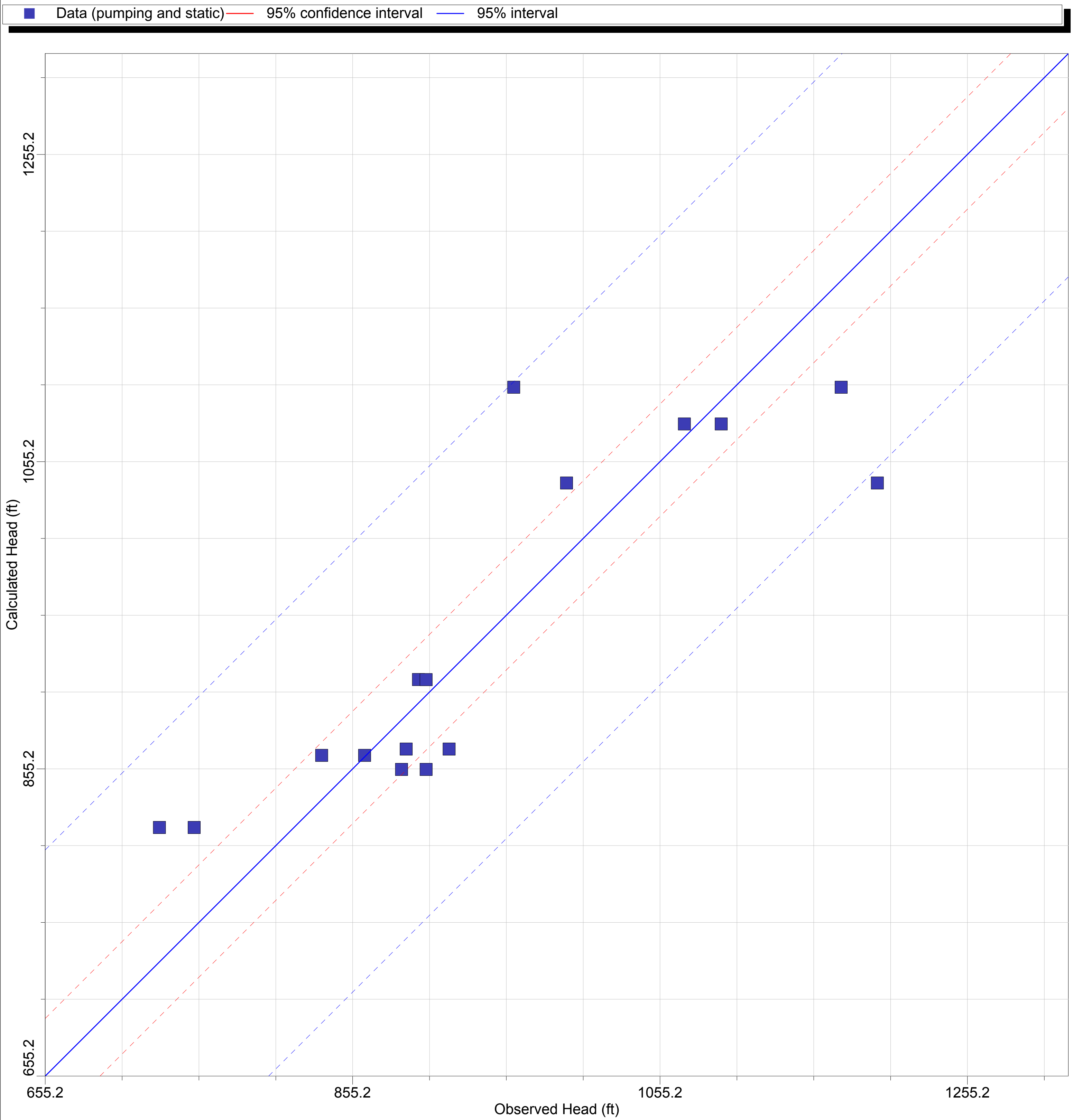
Standard Error of the Estimate : 15.6949 (ft)
Root mean squared : 64.49366 (ft)
Normalized RMS : 18.5379 (%)
Correlation coefficient : 0.8089869

T(0)=January 1990
Time Shown: 3215 days (January 1999)

MWH

Project: Elsinore Basin
Modeller: cdd

Figure D-20 - Model Calibration (January 2000)



Num.Points : 16
Max. Residual: -155.2866 (ft) at L/L
Min. Residual: 0.9388428 (ft) at C_1/C_1
Residual Mean : 0.9484441 (ft)
Absolute Residual Mean : 49.9602 (ft)

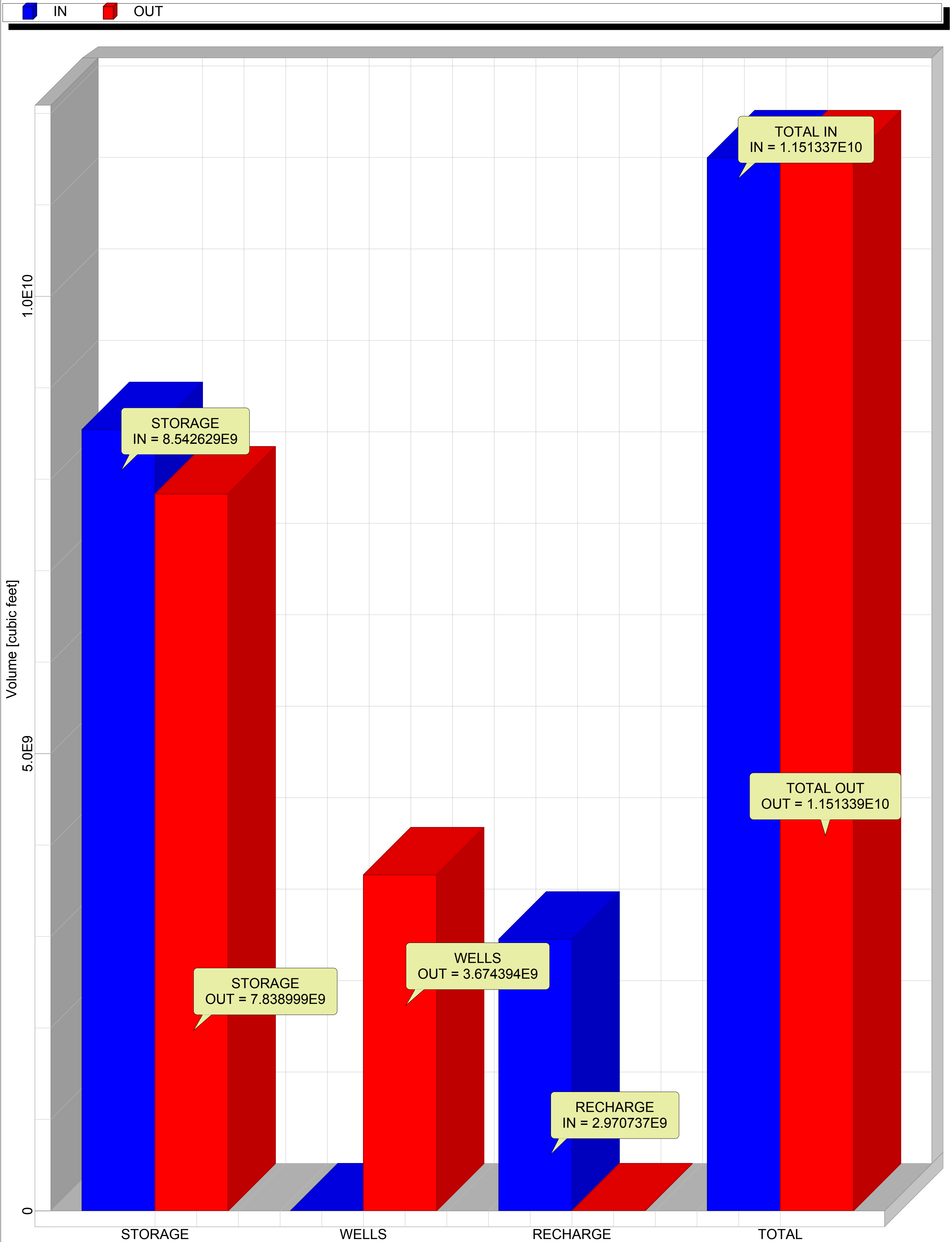
Standard Error of the Estimate : 17.25176 (ft)
Root mean squared : 66.82251 (ft)
Normalized RMS : 14.3067 (%)
Correlation coefficient : 0.8594786

T(0)=January 1990
Time Shown: 3660 days (January 2000)

MWH

Project: Elsinore Basin
Modeller: cdd

Figure D-21 - Mass Balance



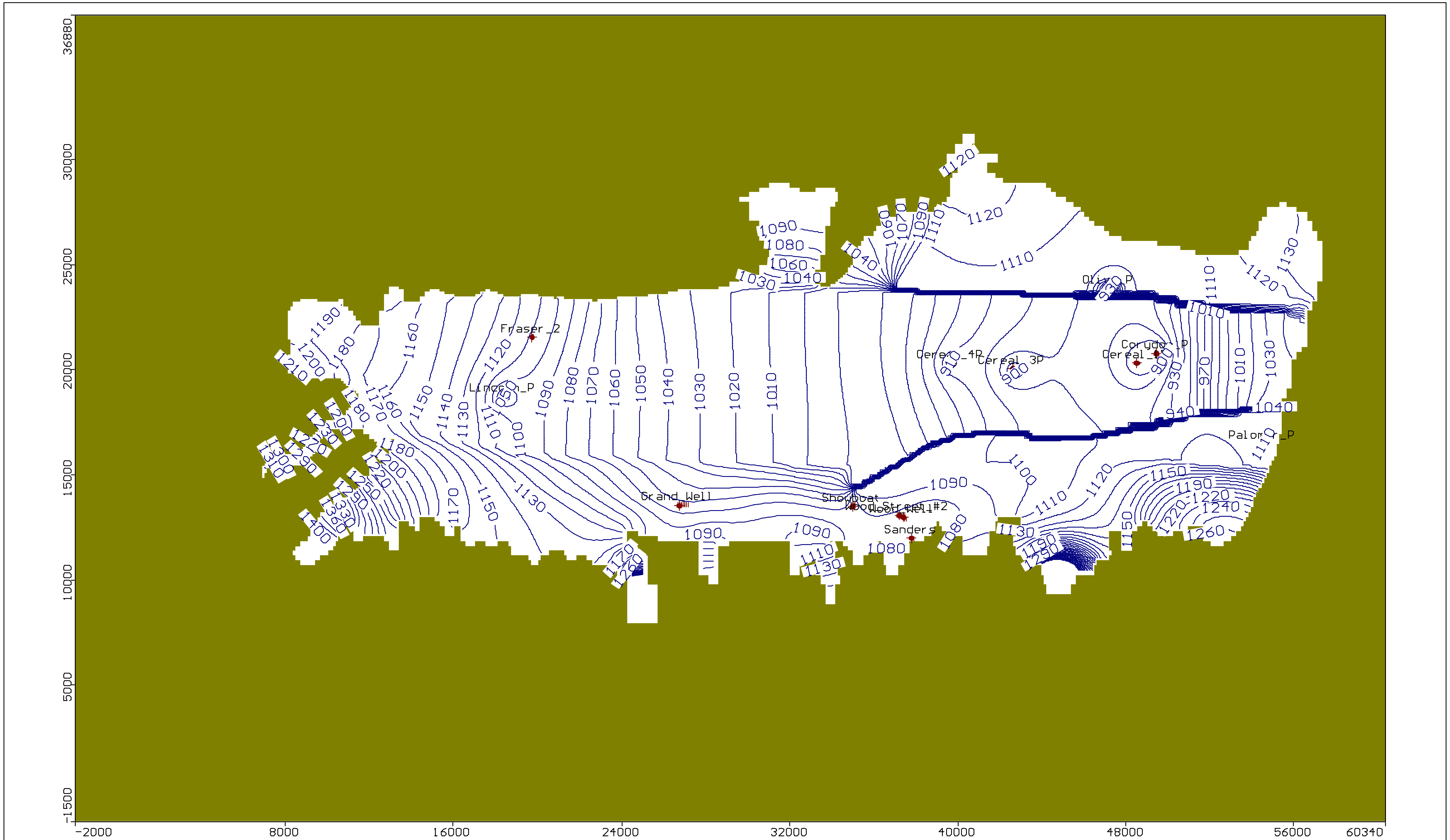
MWH

Mass Balance: MODFLOW
Date: 3/23/2003

Figure D-22
Calculated Equipotentials and Flow Directions: Model Layer 1

HSW Engineering Project: Elsinore Description: Model Layer 1 (1730days) 13 Jun 03	Visual MODFLOW v.3.1.0, (C) 1995-2002 Waterloo Hydrogeologic, Inc. NC: 382 NR: 158 NL: 4 Current Layer: 1

Figure D-23
Calculated Equipotentials and Flow Directions: Model Layer 3



HSW Engineering
Project: Elsinore
Description: Model Layer 3 (1730days)
13 Jun 03

Visual MODFLOW v.3.1.0, (C) 1995-2002
Waterloo Hydrogeologic, Inc.
NC: 382 NR: 158 NL: 4
Current Layer: 3

APPENDIX E – LAKE REPLENISHMENT ANALYSIS

The following describes the methodology for determining the amount of water required to maintain the level of Lake Elsinore.

Lake Level Assumptions

The following presents the relationship between the surface area and the volume of the Lake and the lake level.

Figure E-1
Surface Area versus Lake Level

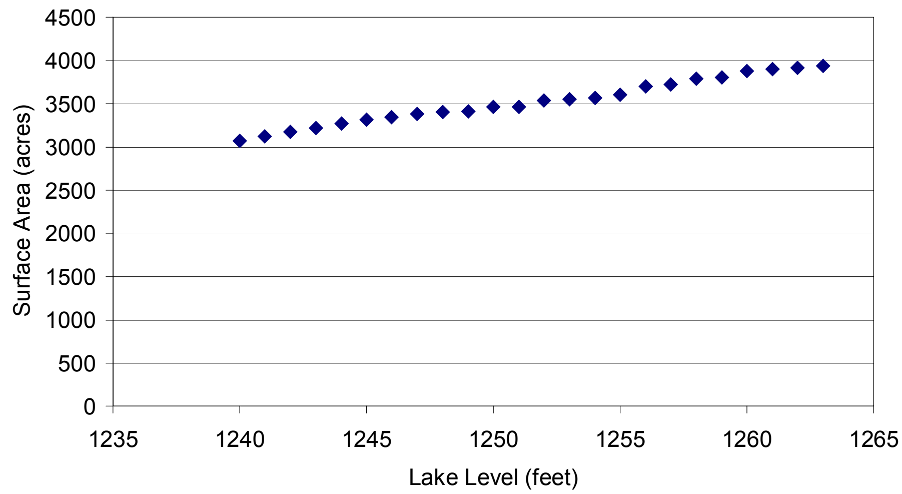
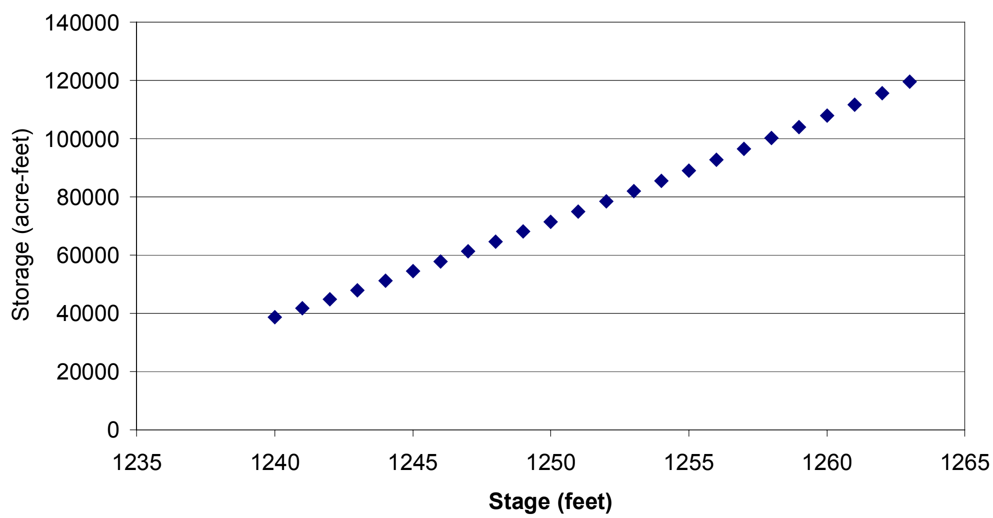


Figure E-2
Stage Storage



The lake parameters were extrapolated above 1263 feet MSL and below 1240 feet MSL.

For modeling purposes, it was assumed that the minimum average lake level was 1229 feet MSL (at which point the lake would be dry). It was also assumed that the lake would overflow to Temescal wash above a level of 1255 feet MSL and spill into the Back Basin at an elevation above 1263 MSL. For simplicity, the model does not differentiate between these overflows and simply assumes that all overflow goes to Temescal Wash.

Historical Balance and Calibration

Inflows to Lake Elsinore include precipitation directly on the lake, inflow from the San Jacinto River, runoff from the local watershed, and lake makeup. For the calibration period, no lake makeup was assumed. Outflows include evaporation and spills to Temescal Wash. The range in inflows and outflows to Lake Elsinore are provided in the following table.

Annual Lake Elsinore Balance (1961-2001)

Parameter	Units	Dry Year 1961	Wet Year 1980	Average
Inflows	AF	1,700	179,200	18,900
Outflows	AF	-15,100	-163,100	-20,000
Net	AF	-13,400	16,100	-1,100

The precipitation (in acre-ft) onto Lake Elsinore was determined by indexing the average precipitation for each time period based upon the County of Riverside isohyetal map and multiplying it by the area of the lake (based upon the previous time step).

The inflow from the San Jacinto River was calculated assuming that flows less than about 15 cfs would be infiltrated into the groundwater basin. Anything over 15 cfs would flow into Lake Elsinore.

The inflows from the remainder of the watershed were estimated using a modification of the results obtained from the San Jacinto Watershed Modeling System software (TetraTech, 2003). The watershed modeling software calculates runoff and nutrient loading from the San Jacinto watershed into Lake Elsinore for the time period from 1990 to 2001. Because the watershed modeling software did not include results prior to 1990, the runoff data calculated using the methodology described in Tech Memo No.3 was compared. In general, the calculated runoff from the runoff model was on the order of 15 percent of the calculated runoff as described in Tech Memo No. 3. This difference occurs because the calculation presented in Tech Memo No. 3 assumes that all runoff generated during a storm event makes it to Lake Elsinore. In reality, factors such as depression storage, evaporation of ponded water and shallow infiltration likely account for the difference.

Figure E-3
Summer Comparison

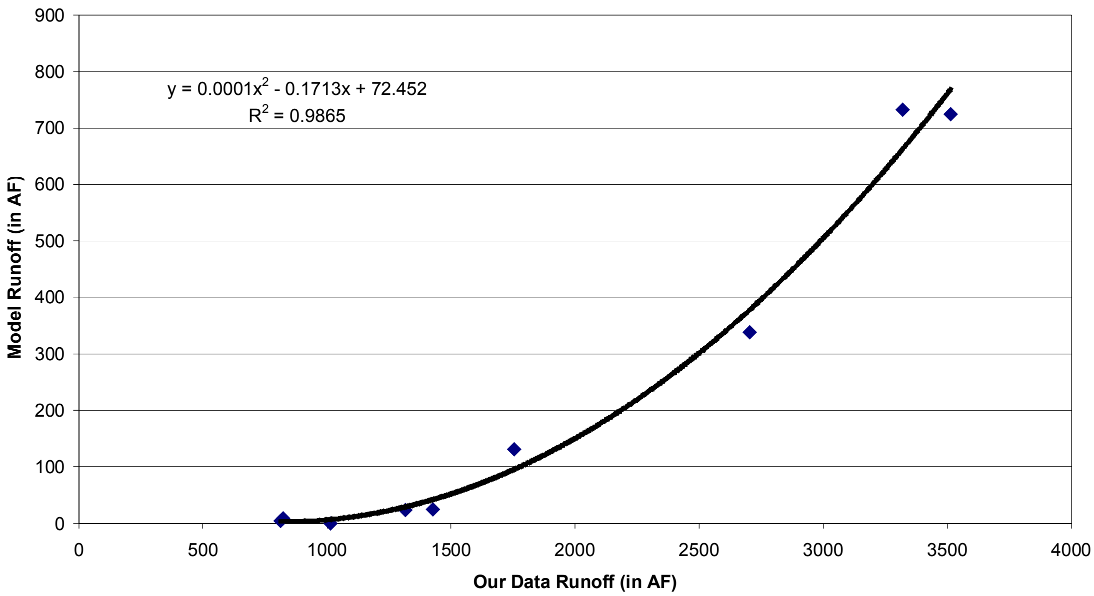
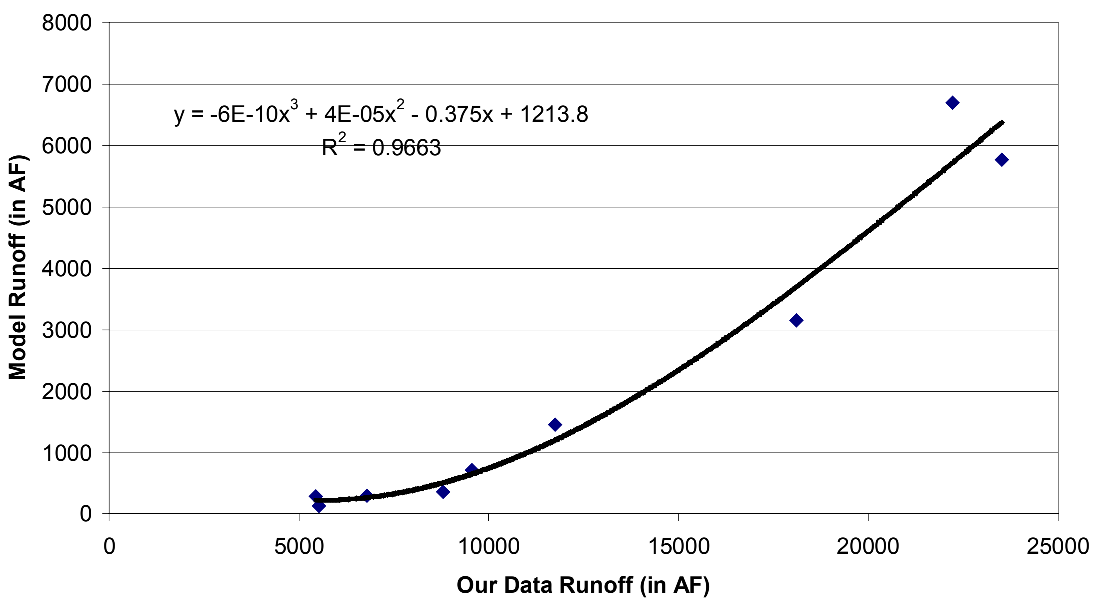


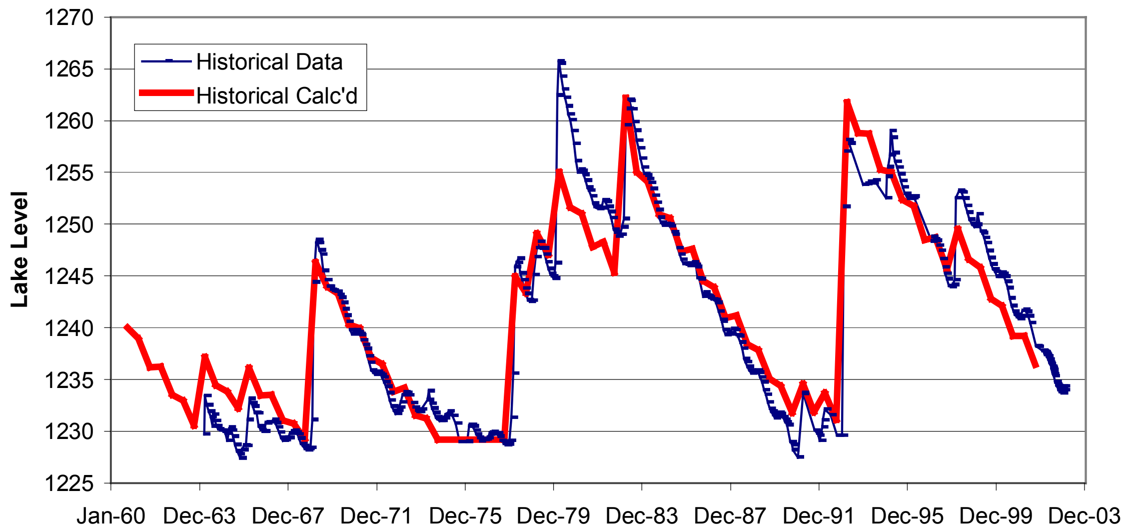
Figure E-4
Winter Comparison



Therefore, the winter and summer runoff data for the historical time period 1961 to 2001 as calculated in TM I-3 were adjusted according to the formulas described above.

Based upon the assumptions summarized above, a simple spreadsheet model was created to model the changes in lake level with historical chances in inflow and outflow. A comparison between the calculated lake level and the actual lake level is provided below.

Figure E-5
Historical Levels of Lake Elsinore



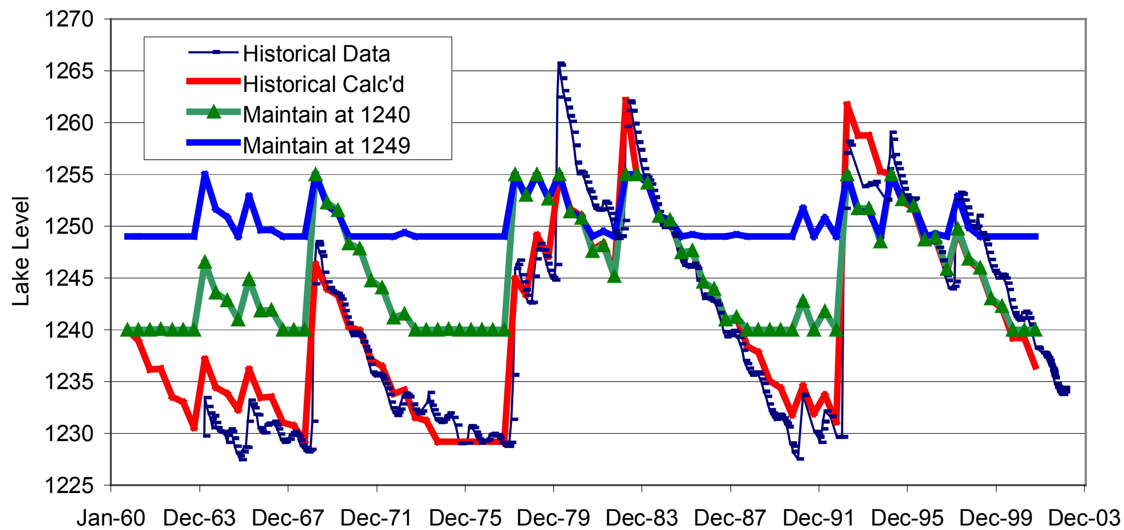
Projected Balance

Lake Levels were calculated assuming both an operating level of 1240 feet MSL and 1249 feet MSL to evaluate the volume of lake makeup water required under each scenario given historical inflows and outflows from the lake. They are described below.

Based upon our discussions with District staff, the following assumptions regarding the Lake for baseline conditions were applied:

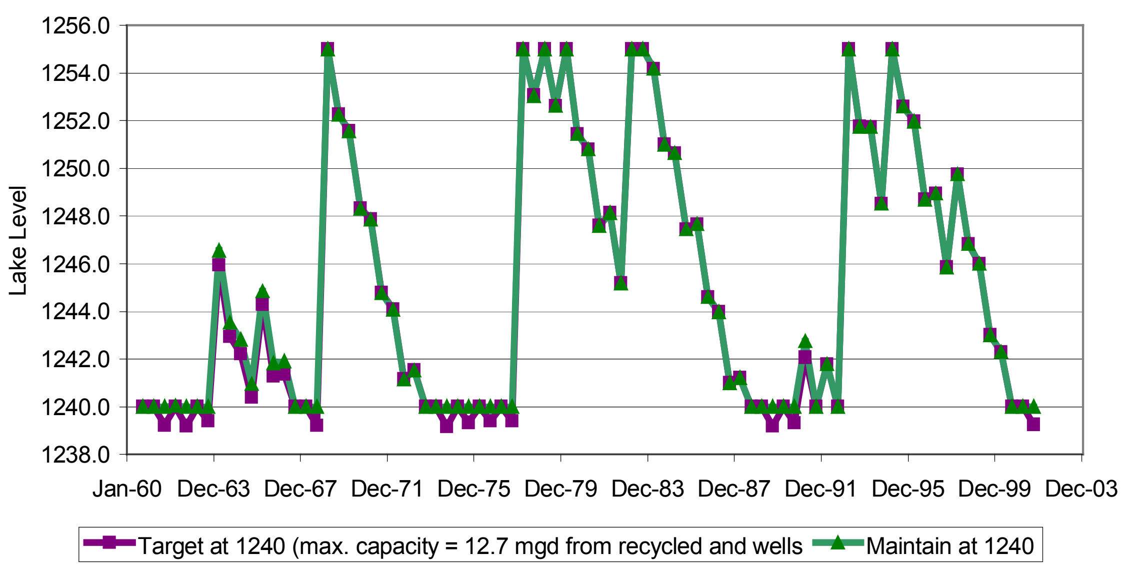
- The target lake level is 1240 feet MSL
- To maintain the lake at this level, approximately 7.5 mgd of reclaimed water would be available for lake makeup
- Once the reclaimed water supply had reached capacity, the wells could be pumped at approximately 5.2 mgd/
- No additional supplies would be available unless lake levels dropped below 1240 feet MSL for more than 2 consecutive 6 month periods

Figure E-6
Projected Levels of Lake Elsinore



The results compared to maintaining the lake at 1240 feet MSL are provided in the following figure.

Figure D-7
Levels of Lake Elsinore when maintained at 1240 feet MSL

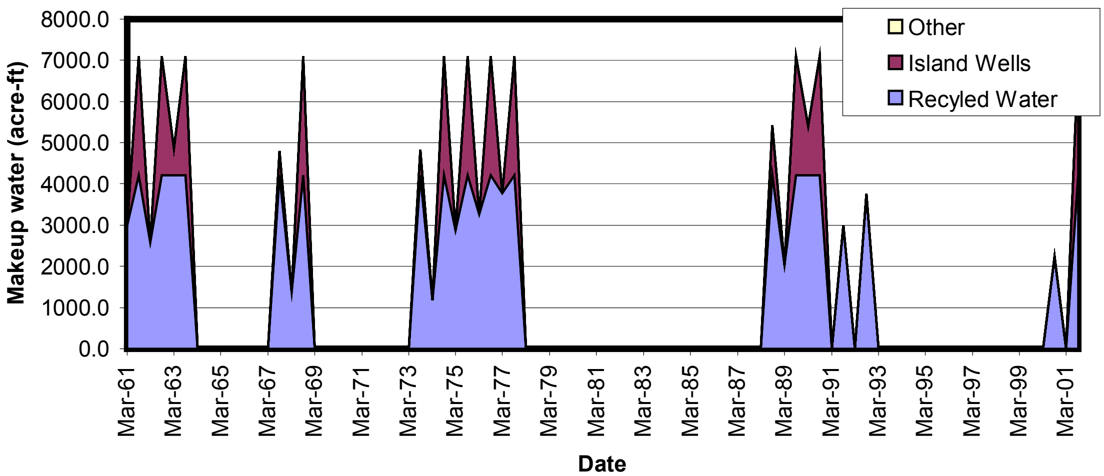


This figure indicates that projected lake levels do not drop below 1240 feet MSL in consecutive 6-month periods. . The makeup water requirements are summarized below.

Table E-1
Summary of Lake Level Maintenance

Parameter	Units	1980 Wet Year	1961 Dry Year	Average
Maintain Minimum Level = 1240'				
Inflows				
Natural Inflows	AF/yr	180,000	2,000	19,000
Lake Makeup	AF/yr	-	13,000	3,000
Total Inflows	AF/yr	**180,000**	**15,000**	**22,000**
Outflows				
Evaporation	AF/yr	23,000	14,000	15,000
Outflows to Temescal Wash	AF/yr	161,000	-	7,000
Total Outflows	AF/yr	**184,000**	**14,000**	**22,000**
Average Lake Elevation	ft MSL	1,245		
Maintain Minimum Level = 1249'				
Inflows				
Natural Inflows	AF/yr	180,000	2,000	19,000
Lake Makeup	AF/yr	-	14,000	7,000
Total Inflows	AF/yr	**180,000**	**16,000**	**26,000**
Outflows				
Evaporation	AF/yr	23,000	16,000	16,000
Outflows to Temescal Wash	AF/yr	161,000	-	10,000
Total Outflows	AF/yr	**184,000**	**16,000**	**26,000**
Average Lake Elevation	ft MSL	1,251		
Additional Calculations				
Average Lake Elevation - No Action	ft MSL	1,241		
Average Water to Temescal Wash	AF/yr	5,000		
Difference between 1249' and 1240'		**Average**		
Additional Water for Lake Makeup	AF/yr	3,400		
Additional Water to Temescal Wash	AF/yr	2,700		
% of Lake Makeup to Temescal Wash	AF/yr	80%		
Difference between 1240' and no action				
Additional Water for Lake Makeup	AF/yr	3,400		
Additional Water to Temescal Wash	AF/yr	1,800		
% of Lake Makeup to Temescal Wash	AF/yr	55%		

Figure E-8
Replenishment Requirements for Level Maintenance at 1240 feet MSL



The following shows the frequency in which lake makeup will be required. As shown in this figure, lake makeup water will be required approximately 35 percent of the time. Similarly, about 15 percent of the time, there will not be enough capacity to meet all of the lake makeup requirements and the lake level will drop below 1240 feet MSL.

Figure E-9
Semi-Annual Lake Replenishment Frequency Curve

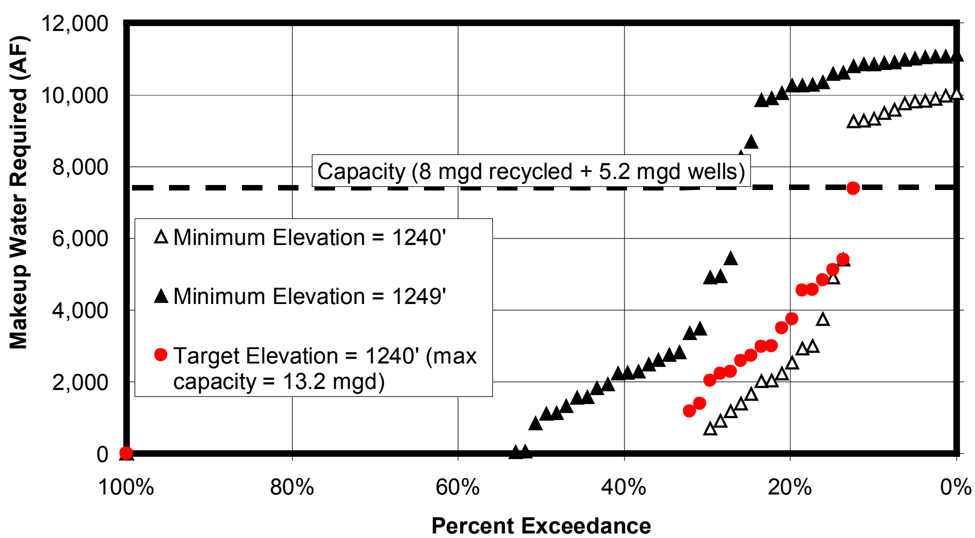


Table F-1
Summary of Potential Water Quality Issues

No.	Potential Management Issue	Assessment Summary	Recommendation
	Identified under AB3030		
1	The control of saline water intrusion	• Not an issue due to the location of the basin	• Not to be addressed
2	Identification and management of wellhead protection areas and recharge areas	• Wellhead protection plan completed for EVMWD's production wells only. • No assessment made for remaining 200+ wells	• Conduct a well canvass (house by house survey) • Expand Well Head Protection Plan • Identify potential contamination paths
3	Regulation of the migration of contaminated groundwater	• No contamination recorded by RWQCB	• Conduct an EDR (environmental data regulation) search • Implement a contamination prevention plan
4	Identification of well construction policies	• The EVWMD wells are constructed in compliance with the DWR Guidelines • The construction policies used for the remaining 200+ wells is unknown	• Include the evaluation of construction methods used in the well canvas • Implement procedures for well construction from this point
5	Administration of a well abandonment and well destruction program	• The basin contains many wells that have an unknown status. • Improper well abandonment is present in the basin	• Include the evaluation of well status and type of abandonment in the well canvas • Implement a Well Abandonment Program
6	The construction and operation of: • Contamination cleanup projects • Storage projects • Recharge projects • Extraction projects • Conservation projects • Water recycling projects	• No current contamination recorded by RWQCB • Strategies are developed for storage, recharge and extraction projects • Conservation can result in reduced return flows • Recycling water is used for lake level maintenance	• Develop Strategies for Basin Storage, Recharge, and Extraction • Evaluate Strategies with groundwater model and cost-benefit analysis. • Evaluate Water Conservation Potential and Impact
7	Activities listed in land use plans which create a risk of groundwater contamination	• Sensitive development areas are the southern part of the Basin and the Canyons where water infiltrates to the basin • The remainder of the basin is protected from contamination by fingering clay layers	• Implement procedures to prevent groundwater pollution from new developments
	Identified for Existing Basin Conditions		
8	Meeting drinking water quality regulations for EVMWD's potable wells	• Water quality information is not available on a consistent basis throughout the basin • Natural occurring Arsenic exists (primarily in the Cereal Wells) • Contamination by bacteria exists in the Olive Street Well (possibly due to septic tanks).	• Develop and implement a water quality monitoring plan • Evaluate the location of the natural occurring Arsenic in more detail to determine actions required
	Identified for Future Basin Conditions		
9	Water quality of imported may not comply with Basin Plan Objectives when injected	• Imported water quality from Skinner (Auld Valley) and Mills (TVP) connection fluctuate, which may lead to exceeding of the Basin Plan Objectives for TDS, Sulfate, and Chloride • Increasing salt concentration as a result of long-term injection • The injectability of Mills water is unknown as the use of this water has not been tested a pilot study	• Compliance with Basin Objective: Action TBD • Perform water quality analysis of the compatibility of Mills water and groundwater • Conduct a pilot test for injecting Mills water when this is part of the recommended strategy.

Table F-2
Summary of Potential Water Quantity Issues

No.	Potential Management Issue	Assessment	Recommendation/Action
	Identified under AB3030		
10	Mitigation of conditions of overdraft	• No groundwater level information was available for the EWD Wells • Declining groundwater levels in the southern part of the Basin.	• Gather water level data from EWD • Declining Levels Back Basin: To be determined in this GWMP
11	Replenishment of groundwater extracted by water producers	• Groundwater is not replenished in the back basin as levels are declining • Groundwater is replenished in the area north of the lake as levels are stable	• Declining Levels the southern part of the basin: To be determined in this GWMP • Maintain levels in the area north of the lake • Include basin level maintenance as an objective in the management strategies

No.	Potential Management Issue	Assessment	Recommendation/Action
12	Monitoring of groundwater production, levels, and storage.	• Groundwater production is monitored recorded on a regular basis by EVMWD and EWD only • Water levels and production records for remaining 200+ wells are reported inconsistently or not available. • Water level information at production wells has a poor reliability due to unknown stabilization time of production wells	• Include the evaluation of well status, water use, and production recording method in the well canvas • Determine number of active wells in the basin • Develop a monitoring program for water production and water level measurements • Implement a production recording system with the basin pumpers • Measure water levels at non-production wells
13	Facilitating conjunctive use operations	• This is the purpose of the GWMP (not a management issue)	• Evaluate various conjunctive use strategies
	Identified for Existing Basin Conditions		
14	A doubling of water demands in 20 years leads to a water supply shortfall	• Water Demands are projected to exceed the supplies in Year 2011 • Additional water supplies are required • The use of available reclaimed water for water conservation is limited due to the need of lake level replenishment with reclaimed water	• Promote water conservation • Implement conjuctive use operations • Identify additional new sources of supply • Evaluate the cost-effectiveness of using untreated imported water through the Canyon Lake Spills for surface recharge
15	Increasing dependence on imported water supplies	• Imported water will be 80 percent of the water supply in 2020 • Decreasing water supply reliability • Cost of imported water are estimated to be higher than implementing conjunctive use	• Develop strategies that increase water supply reliability • Implement conjunctive use operations
16	Groundwater is required for lake replenishment	• It is uncertain whether reclaimed water is acceptable for replenishment • The need for lake replenishment water from the basin increases when runoff water is used for surface recharge	• Include the groundwater needs for lake replenishment in the strategy evaluation • Evaluate the cost-effectiveness of increasing the use of untreated imported through the Canyon Lake Spill for lake replenishment
17	Reduced groundwater recharge as a result of increasing urbanization	• Urbanization potential in the basin area is limited due to topography and flood plain • Reduced recharge does not negatively impact the basin storage as the runoff will reach the lake, reducing the need for level maintenance water from the basin	• Not to be addressed
	Identified for Future Basin Conditions		
18	Impact of groundwater management activities on hotspring wells	• Not anticipated to be an issue as the hotspring wells are located north of the Glen Ivy Fault (north of the basin)	• No action
19	Groundwater storage may lead to a groundwater outflow.	• Groundwater outflows at the southeastern end of the basin may occur if groundwater levels will rise above the saddle height.	• Evaluate potential of groundwater outflows with groundwater model. • Prevent outflows by adjusting water storage levels

Table F-3
Summary of Other Potential Management Issues

No.	Potential Management Issue	Assessment	Recommendation/Action
	Identified under AB3030		
20	Development of relationships with State and Federal Regulatory Agencies	• The District is evaluating the benefit of including Regulatory Agencies in the Stakeholders Process	• Pending and further recommendations follow in this GWMP
	Identified for Existing Basin Conditions		
21	Limited information on recharge characteristics	• The “Sedco Cone” location is unknown • Recharge capacities in the canyons are unknown	• Evaluate the “Sedco Cone’ location with the groundwater model • Conduct pilot testing for recharge locations in preferred strategy
	Identified for Future Basin Conditions		
22	Risk of subsidence	• Decreasing groundwater levels as a result of ASR operations may lead to subsidence when clay layers are dewatered • The basin’s storage capacity will decrease as a result of subsidence.	• Include surface level measurements in the monitoring program • Determine the water level operating range conservatively. • Evaluate the subsidence potential for the preferred alternative.
23	Risk of liquefaction	• Liquefaction may occur in perched areas due to increased groundwater levels in combination of an earthquake. • Potential areas for liquefaction are located in the northern portion of the back basin	• Conduct Cone Penetrometer Testing (CPT) in the back basin area to determine the potential of liquefaction.

APPENDIX G– DETAILS ON WATER CONSERVATION PROGRAMS

Low Water Use Landscaping

Low water use landscaping can be created by adhering to the following key principals:

- Plan and design comprehensively with the consideration of aesthetics, soil type, sloping, intended land use, and native plants.
- Evaluate soil for plant selection and improve if necessary with amendments, such as, spaghnum peat moss or compost to improve root development, water penetration and retention.
- Select the size and location of turf areas based on the purpose and function in the landscape. A reduction of turf areas, and locating them separately, can result in significant reductions in water use due to more efficient watering.
- Use appropriate plants and group according to their water needs and a focus on varieties that have low water needs.
- Water efficiently with properly designed irrigation systems.
- Use organic mulches to reduce evaporation and weed growth, slow erosion, and help prevent soil temperature fluctuations.
- Practice appropriate maintenance: proper pruning, weeding and fertilization, plus attention to the irrigation system, will preserve and enhance the quality of the low water use landscaping.

Water Conservation Program of LADWP

The following strategies for implementing water conservation in households are recommended by the Los Angeles Department of Water and Power (LADWP):

- Check for household leaks
- Displace water in toilet tank or buy an ultra-low-flush toilet
- Water saving shower heads, and take shorter showers
- Turn off the water while brushing teeth, shaving, cleaning vegetables, washing dishes, or washing your car.
- Use appliances such as dishwater and washing machine only when full
- Water lawns deeply and less frequently, early in the morning or late in the evening. Change watering frequency based on season and time of day.
- Use a broom instead of a hose.

The ten recommended steps to conserving water for businesses are:

1. Start with a desire to eliminate waste
2. Appoint a Conservation Manager
3. Determine where your water is used
4. Check your system for leaks
5. Set a conservation goal

6. Apply common sense
7. Involve your employees
8. Install low flow devices
9. Be aware of water efficient equipment
10. Monitor your results

Examples of Rebate Programs

Based on an evaluation of rebate programs of other agencies, including LADWP and MWD, rebates commonly offered are:

- A $150 rebate for residential customers who purchase qualifying high efficiency clothes washers.
- A $250 rebate for commercial customers who purchase qualifying high efficiency clothes washers.
- A $100 for residential customers who replace a toilet in a single family residence and a $75 rebate for each toilet replaced in a multi-family residence.
- A $50 rebate for commercial customers who purchase pre-rinse kitchen sprayers.

In addition, MWD will pay as much as $154 for every acre-foot of water that is saved from industrial process changes done to increase water efficiency. MWD will provide payment for up to five years as long as the process change is expected to save at least 10 acre-feet of water per year (MWD, 2003).

Implementation of Rebate Programs

Implementing a financial incentives program for water conservation would involve the following tasks:

1. Acquiring funds
2. Informing the community about the available rebates and benefits
3. Carrying out the rebate program
4. Tracking participation rates to evaluate the effectiveness of the programs

There are existing programs in California already in place to provide assistance to agencies in both of these capacities. For example, MWD's Innovative Conservation Program portion is designed to provide grants to explore the water savings potential and practicality of new water conserving technologies. Similarly, the Bureau of Reclamation has the Water Conservation Field Services Program (WCFSP) to assist water agencies in developing and implementing effective water management and conservation plans. One of the WCFSP's areas of emphasis is conservation education, and this program could be particularly useful in formulating an outreach effort to accomplish Task 2 above.

APPENDIX H - COST ESTIMATES

Capital Cost - Baseline B

Item	Number	Unit	Unit Cost	Total Cost	Depreciation Period (yrs)	Annual Capital Cost
Peaking Wells	11	wells	$ 1,870,000	$ 20,570,000	75	$ 693,000
Electrical Upgrades of Wells (motor, electrics, pump)	21	wells	$ 100,000	$ 2,100,000	20	$ 142,000
Re-equipment of Wells (pump column, pump, motor, electr.)	14	wells	$ 200,000	$ 2,800,000	75	$ 95,000
20-inch diameter pipeline (parallel to TVP) of 62,000 LF	1	pipeline	$ 15,110,000	$ 15,110,000	40	$ 654,000
12-inch diameter pipeline (parallel to TVP) of 8,400 LF	1	pipeline	$ 840,000	$ 840,000	40	$ 37,000
36-inch diameter pipeline on Collier Ave. from Riverside Dr. to Central Ave (4,000 LF)	1	pipeline	$ 1,760,000	$ 1,760,000	40	$ 77,000
30-inch diameter pipeline from Collier & Central to Lakeshore & Railroad Canyon (20,000 LF)	1	pipeline	$ 6,790,000	$ 6,790,000	40	$ 294,000
Total				**$ 49,970,000**		**$ 1,992,000**

O& M - Baseline B

Item	Quantity	Unit	Unit Cost	Annual Cost
Groundwater Pumping in Back Basin Area	6,522	acre-feet/yr	$ 139	$ 909,000
Groundwater Pumping N/O Lake	4,378	acre-feet/yr	$ 124	$ 545,000
Groundwater Pumping EWD	400	acre-feet/yr	$ 95	$ 39,000
Groundwater Pumping Lake Replenishment	900	acre-feet/yr	$ 129	$ 117,000
Recycled water for Lake Replenishment	2,300	acre-feet/yr	$ 150	$ 345,000
Canyon Lake WTP	3,000	acre-feet/yr	$ 230	$ 690,000
Purchase of MWD Water (Tier 1)	13,320	acre-feet/yr	$ 418	$ 5,568,000
Purchase of MWD Water (Tier 2)	21,580	acre-feet/yr	$ 499	$ 10,769,000
Purchase of MWD Water for In-Lieu recharge	0	acre-feet/yr	$ 300	$ -
Additional Source (MWD Tier 2)	1,300	acre-feet/yr	$ 499	$ 648,700
Total				**$ 19,630,700**

Unit Cost per Acre-foot - Baseline B

Item	Annual Cost	Water Supply (acre-feet/yr)	Water Supply Cost ($/acre-feet)
Capital Cost	$ 1,992,000		
O & M Cost	$ 19,630,700		
Total	**$ 21,622,700**	**50,500**	**$ 428**

APPENDIX H - COST ESTIMATES

Capital Cost - Alternative 1

Item	Number	Unit	Unit Cost	Total Cost	Depreciation Period (yrs)	Annual Capital Cost
Peaking Wells	4	wells	$ 1,870,000	$ 7,480,000	75	$ 252,000
Electrical Upgrades of Wells (motor, electrics, pump)	4	wells	$ 100,000	$ 400,000	20	$ 27,000
Re-equipment of Wells (pump column, pump, motor,	0	wells	$ 200,000	$ -	75	$ -
Conversion of Existing Wells to Dual Purpose Wells	4	wells	$ 100,000	$ 400,000	20	$ 27,000
New Dual Purpose Wells	10	wells	$ 1,870,000	$ 18,700,000	75	$ 630,000
30-inch diameter pipeline on Corydon Street (4,000 LF)	1	pipelines	$ 1,360,000	$ 1,360,000	40	$ 59,000
800 HP in-line PS(near Clinton Keith Rd./I-15)	1	PS	$ 1,680,000	$ 1,680,000	20	$ 113,000
Total				**$ 30,020,000**		**$ 1,108,000**

O& M - Alternative 1

Item	Quantity	Unit	Unit Cost	Annual Cost
Groundwater Pumping in Back Basin Area	6,163	acre-feet/yr	$ 86	$ 532,000
Groundwater Pumping N/O Lake	4,137	acre-feet/yr	$ 99	$ 409,000
Groundwater Pumping EWD	400	acre-feet/yr	$ 91	$ 37,000
Groundwater Pumping Lake Replenishment	900	acre-feet/yr	$ 84	$ 76,000
Recycled water for Lake Replenishment	2,300	acre-feet/yr	$ 150	$ 345,000
Canyon Lake WTP	3,000	acre-feet/yr	$ 230	$ 690,000
Purchase of MWD Water (Tier 1)	13,320	acre-feet/yr	$ 418	$ 5,568,000
Purchase of MWD Water (Tier 2)	22,580	acre-feet/yr	$ 499	$ 11,268,000
Purchase of MWD Water for Injection	6,700	acre-feet/yr	$ 300	$ 2,010,000
Purchase of MWD Water for In-Lieu recharge	900	acre-feet/yr	$ 300	$ 270,000
Pumping Cost in-line PS (near Clinton Keith Rd./I-15)	12,000	acre-feet/6 mo	$ 19	$ 232,000
Total				**$ 21,437,000**

Unit Cost per Acre-foot - Alternative 1

Item	Annual Cost	Water Supply (acre-feet/yr)	Water Supply Cost ($/acre-feet)
Capital Cost	$ 1,108,000		
O & M Cost	$ 21,437,000		
Total	**$ 22,545,000**	**50,500**	**$ 446**

APPENDIX H - COST ESTIMATES

Capital Cost - Alternative 2

Item	Number	Unit	Unit Capital Cost	Total Capital Cost	Depreciation Period (yrs)	Annual Capital Cost
Peaking Wells	11	wells	$ 1,870,000	$ 20,570,000	75	$ 693,000
Electrical Upgrades of Wells (motor, electrics, pump)	17	wells	$ 100,000	$ 1,700,000	20	$ 115,000
Re-equipment of Wells (pump column, pump, motor, electr.)	11	wells	$ 200,000	$ 2,200,000	75	$ 75,000
New extraction Wells near McVicker Canyon	2	wells	$ 940,000	$ 1,880,000	75	$ 64,000
New extraction Wells near Leach Canyon	2	wells	$ 940,000	$ 1,880,000	75	$ 64,000
New extraction Well N/O the Lake (deep)	1	wells	$ 1,870,000	$ 1,870,000	75	$ 63,000
Upper Leach Canyon Spreading Ponds	11	acres	$ 170,000	$ 1,870,000	20	$ 126,000
Lower Leach Canyon Spreading Ponds	14	acres	$ 230,000	$ 3,220,000	20	$ 217,000
McVicker Canyon Spreading Ponds	15	acres	$ 540,000	$ 8,100,000	20	$ 545,000
24-inch diameter pipeline to McVicker Park (5,000 LF)	3	pipelines	$ 1,360,000	$ 4,080,000	40	$ 177,000
36-inch diameter pipeline to McVicker Park (6,000 LF)	1	pipelines	$ 2,640,000	$ 2,640,000	40	$ 115,000
30-inch diameter pipeline to Leach Canyon (7,400 LF)	2	pipelines	$ 2,520,000	$ 5,040,000	40	$ 219,000
800 HP pumping station	1	PS	$ 1,680,000	$ 1,680,000	20	$ 113,000
12-inch diameter pipeline from Leach 1 Well to the Loopzone (1,400 LF)	1	pipelines	$ 240,000	$ 240,000	40	$ 11,000
12-inch diameter pipeline from Leach 2 Well to the Loopzone (1,000 LF)	1	pipelines	$ 170,000	$ 170,000	40	$ 8,000
12-inch diameter pipeline from Terra Cotta Well to the Loopzone (1,400 LF)	1	pipelines	$ 240,000	$ 240,000	40	$ 11,000
Total				**$ 57,380,000**		**$ 2,616,000**

O& M - Alternative 2

Item	Quantity	Unit	Unit Cost	Annual Cost
Groundwater Pumping in Back Basin Area	7,450	acre-feet/yr	$ 136	$ 1,017,000
Groundwater Pumping N/O Lake	4,750	acre-feet/yr	$ 106	$ 503,000
Groundwater Pumping EWD	400	acre-feet/yr	$ 105	$ 42,000
Groundwater Pumping Lake Replenishment	900	acre-feet/yr	$ 125	$ 113,000
Recycled water for Lake Replenishment	2,300	acre-feet/yr	$ 150	$ 345,000
Canyon Lake WTP	3,000	acre-feet/yr	$ 230	$ 690,000
Purchase of MWD Water (Tier 1)	13,320	acre-feet/yr	$ 418	$ 5,568,000
Purchase of MWD Water (Tier 2)	21,580	acre-feet/yr	$ 499	$ 10,769,000
Purchase of MWD Water for Surface Spreading	3,800	acre-feet/yr	$ 300	$ 1,140,000
Purchase of MWD Water for In-Lieu recharge	0	acre-feet/yr	$ 300	$ -
Maintenance of Surface Spreading Ponds	4,200	acre-feet/yr	$ 10	$ 42,000
Pumping Cost of Imported Water to Spreading Basins	4,200	acre-feet/yr	$ 55	$ 232,000
Total				**$ 20,461,000**

Unit Cost per Acre-foot - Alternative 2

Item	Annual Cost	Water Supply (acre-feet/yr)	Water Supply Cost ($/acre-feet)
Capital Cost	$ 2,616,000		
O & M Cost	$ 20,461,000		
Total	**$ 23,077,000**	**50,500**	**$ 457**

APPENDIX H - COST ESTIMATES

Capital Cost - Alternative 3

Item	Number	Unit	Unit Cost	Total Cost	Depreciation Period (yrs)	Annual Capital Cost
Peaking Wells	8	wells	$ 1,870,000	$ 14,960,000	75	$ 504,000
Electrical Upgrades of Wells (motor, electrics, pump)	8	wells	$ 100,000	$ 800,000	20	$ 54,000
Re-equipment of Wells (pump column, pump, motor, electr.)	0	wells	$ 200,000	$ -	75	$ -
Total				**$ 15,760,000**		**$ 558,000**

O& M - Alternative 3

Item	Quantity	Unit	Unit Cost	Annual Cost
Groundwater Pumping in Back Basin Area	2,842	acre-feet/yr	$ 95	$ 270,000
Groundwater Pumping N/O Lake	898	acre-feet/yr	$ 83	$ 75,000
Groundwater Pumping EWD	360	acre-feet/yr	$ 83	$ 30,000
Groundwater Pumping Lake Replenishment	900	acre-feet/yr	$ 89	$ 81,000
Recycled water for Lake Replenishment	2,300	acre-feet/yr	$ 150	$ 345,000
Canyon Lake WTP	3,000	acre-feet/yr	$ 230	$ 690,000
Purchase of MWD Water (Tier 1)	13,320	acre-feet/yr	$ 418	$ 5,568,000
Purchase of MWD Water (Tier 2)	21,180	acre-feet/yr	$ 499	$ 10,569,000
Purchase of MWD Water for In-Lieu recharge	3,900	acre-feet/yr	$ 300	$ 1,170,000
Water Conservation	5,000	acre-feet/yr	$ 260	$ 1,300,000
Total				**$ 20,098,000**

Unit Cost per Acre-foot - Alternative 3

Item	Annual Cost	Water Supply (acre-feet/yr)	Water Supply Cost ($/acre-feet)
Capital Cost	$ 558,000		
O & M Cost	$ 20,098,000		
Total	**$ 20,656,000**	**50,500**	**$ 409**

APPENDIX H - COST ESTIMATES

Capital Cost - Alternative 4

Item	Number	Unit	Unit Cost	Total Cost	Depreciation Period (yrs)	Annual Capital Cost
Peaking Wells	4	wells	$ 1,870,000	$ 7,480,000	75	$ 252,000
Electrical Upgrades of Wells (motor, electrics, pump)	0	wells	$ 100,000	$ -	20	$ -
Re-equipment of Wells (pump column, pump, motor, electr.)	0	wells	$ 200,000	$ -	75	$ -
Conversion of Existing Wells to Dual Purpose Wells	6	wells	$ 100,000	$ 600,000	20	$ 41,000
Equipping Joy Street as a Dual Purpose Well	1	wells	$ 100,000	$ 100,000	20	$ 7,000
New Dual Purpose Wells	7	wells	$ 1,870,000	$ 13,090,000	75	$ 441,000
30-inch diameter pipeline on Corydon Street (4,000 LF)	1	pipelines	$ 1,360,000	$ 1,360,000	40	$ 59,000
800 HP in-line PS (near Clinton Keith Rd./I-15)	1	PS	$ 1,680,000	$ 1,680,000	20	$ 113,000
Total				**$ 24,310,000**		**$ 913,000**

O& M - Alternative 4

Item	Quantity	Unit	Unit Cost	Annual Cost
Groundwater Pumping in Back Basin Area	8,188	acre-feet/yr	$ 84	$ 691,000
Groundwater Pumping N/O Lake	2,132	acre-feet/yr	$ 78	$ 166,000
Groundwater Pumping EWD	380	acre-feet/yr	$ 81	$ 31,000
Groundwater Pumping Lake Replenishment	0	acre-feet/yr	$ 68	$ -
Recycled water for Lake Replenishment	3,400	acre-feet/yr	$ 150	$ 510,000
Canyon Lake WTP	3,000	acre-feet/yr	$ 230	$ 690,000
Purchase of MWD Water (Tier 1)	13,320	acre-feet/yr	$ 418	$ 5,568,000
Purchase of MWD Water (Tier 2)	19,880	acre-feet/yr	$ 499	$ 9,921,000
Purchase of MWD Water for Injection	5,900	acre-feet/yr	$ 300	$ 1,770,000
Purchase of MWD Water for In-Lieu recharge	1,100	acre-feet/yr	$ 300	$ 330,000
Pumping Cost in-line PS (near Clinton Keith Rd./I-15)	12,000	acre-feet/6 mo	$ 19	$ 232,000
Water Conservation	2,500	acre-feet/yr	$ 260	$ 650,000
Total	**71,800**			**$ 20,559,000**

Unit Cost per Acre-foot - Alternative 4

Item	Annual Cost	Water Supply (acre-feet/yr)	Water Supply Cost ($/acre-feet)
Capital Cost	$ 913,000		
O & M Cost	$ 20,559,000		
Total	**$ 21,472,000**	**50,500**	**$ 425**

APPENDIX H _ COST ESTIMATES

Cost Comparison of Different Sources for Surface Spreading
(Excludes the capital and O&M cost of spreading basins)

Item	Option 1 Treated, Imported Water	Option 2 Untreated Imported Water	Option 3 Reclaimed Water from Regional WWTP	Option 4 Reclaimed Water fom EMWD's WWTP	Option 5 Reclaimed Water fom EMWD's WWTP
Spreading (acre-ft/6 mos)	**4,200**	**4,200**	**2,100**	**2,100**	**4,200**
Capital Cost	$ 8,400,000	$ 28,400,000	$ 15,200,000	$ 16,400,000	$ 23,100,000
Annual Capital Cost	$ 337,000	$ 1,053,000	$ 605,000	$ 641,000	$ 928,000
Annual Power Cost	$ 232,000	$ 580,000	$ 464,000	$ 638,000	$ 812,000
Annual Supply Cost	$ 1,260,000	$ 978,600	$ 630,000	$ 976,500	$ 1,323,000
Total Annual Cost	$ 1,829,000	$ 2,611,600	$ 1,699,000	$ 2,255,500	$ 3,063,000
Unit Cost per acre-foot	**$ 435**	**$ 622**	**$ 809**	**$ 1,074**	**$ 729**

Option 1 - Treated, Imported Water	**Diameter (in)**	**Length (ft)**	**Construction Cost**	**Rounded Capital Cost**
Pipeline to McVicker Park	36	6,000	$ 1,618,725	$ 2,700,000
Pipeline to Leach Canyon	30	7,400	$ 1,544,855	$ 2,600,000
Pipeline to McVicker Canyon	24	5,000	$ 835,057	$ 1,400,000
Pump Station	800	HP	$ 1,027,762	$ 1,700,000
Total Capital Cost				**$ 8,400,000**

Option 2 - Untreated Imported Water	**Diameter (in)**	**Length (ft)**	**Construction Cost**	**Rounded Capital Cost**
Pipeline to McVicker Park	36	48,000	$ 12,949,800	$ 21,100,000
Pipeline to Leach Canyon	30	7,400	$ 1,544,855	$ 2,600,000
Pipeline to McVicker Canyon	24	5,000	$ 835,057	$ 1,400,000
Pump Station	2000	HP	$ 2,000,000	$ 3,300,000
Total Capital Cost				**$ 28,400,000**

Option 3 - Reclaimed Water from Regional WWTP	**Diameter (in)**	**Length (ft)**	**Construction Cost**	**Rounded Capital Cost**
Pipeline to McVicker Park	24	22,000	$ 3,674,249	$ 6,000,000
Pipeline to Leach Canyon	20	7,400	$ 1,109,126	$ 1,900,000
Pipeline to McVicker Canyon	16	5,000	$ 599,528	$ 1,000,000
Pump Station	1200	HP	$ 1,284,702	$ 2,100,000
50 percent of capital cost - treated importe				$ 4,200,000
Total Capital Cost				**$ 15,200,000**

Option 4 - Reclaimed Water fom Eastern MWD (50%)	**Diameter (in)**	**Length (ft)**	**Construction Cost**	**Rounded Capital Cost**
Pipeline to McVicker Park	24	25,000	$ 4,175,283	$ 6,800,000
Pipeline to Leach Canyon	24	7,400	$ 1,235,884	$ 2,100,000
Pipeline to McVicker Canyon	20	5,000	$ 749,410	$ 1,300,000
Pump Station	1200	HP	$ 1,200,000	$ 2,000,000
50 percent of capital cost - treated importe				$ 4,200,000
Total Capital Cost				**$ 16,400,000**

Option 5 - Reclaimed Water fom Eastern MWD (100%)	**Diameter (in)**	**Length (ft)**	**Construction Cost**	**Rounded Capital Cost**
Pipeline to McVicker Park	36	25,000	$ 6,744,688	$ 11,000,000
Pipeline to Leach Canyon	30	7,400	$ 1,544,855	$ 2,600,000
Pipeline to McVicker Canyon	24	5,000	$ 835,057	$ 1,400,000
Pump Station	2400	HP	$ 2,400,000	$ 3,900,000
50 percent of capital cost - treated importe				$ 4,200,000
Total Capital Cost				**$ 23,100,000**

Pump Operations	Option 1 Treated, Imported Water	Option 2 Untreated Imported Water	Option 3 Reclaimed Water from Regional WWTP	Option 4 Reclaimed Water fom EMWD's WWTP	Option 5 Reclaimed Water fom EMWD's WWTP
Hp when running	600	1,500	900	900	1,800
kW when running	447	1,119	671	671	1,342
Cost (per kWh)	$ 0.12	$ 0.12	$ 0.12	$ 0.12	$ 0.12
Spreading (acre-ft/6 mos)	4,200	4,200	2,100	2,100	4,200
Days pump use per year	180	180	180	180	180
Hours pump use per year	4,320	4,320	4,320	4,320	4,320
kWh per Year	1,932,854	4,832,136	2,899,282	2,899,282	5,798,563
Power Cost per Year	$ 231,943	$ 579,856	$ 347,914	$ 347,914	$ 695,828
Power Cost 50% Imported MWD			$ 115,971	$ 289,928	$ 115,971
Total Power Cost	$ 231,943	$ 579,856	$ 463,885	$ 637,842	$ 811,799
Power Cost per acre-ft	$ 55	$ 138	$ 221	$ 304	$ 193

Appendix I
Model Results

Figure 1
Baseline B Groundwater Results

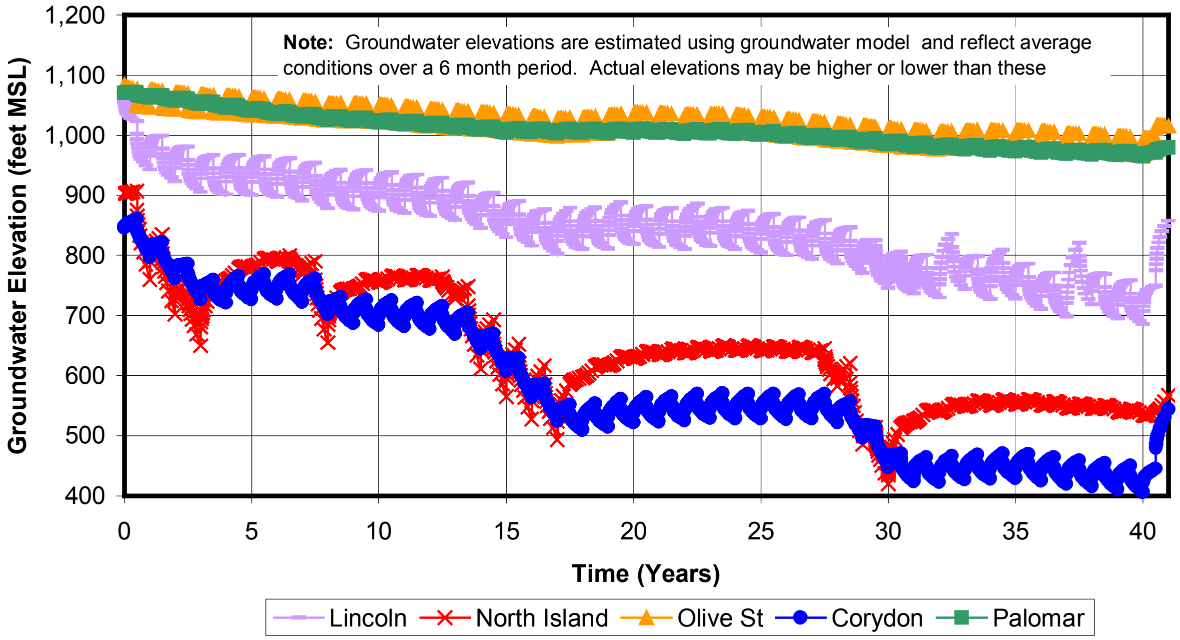


Figure 2
Alternative 1 Groundwater Results

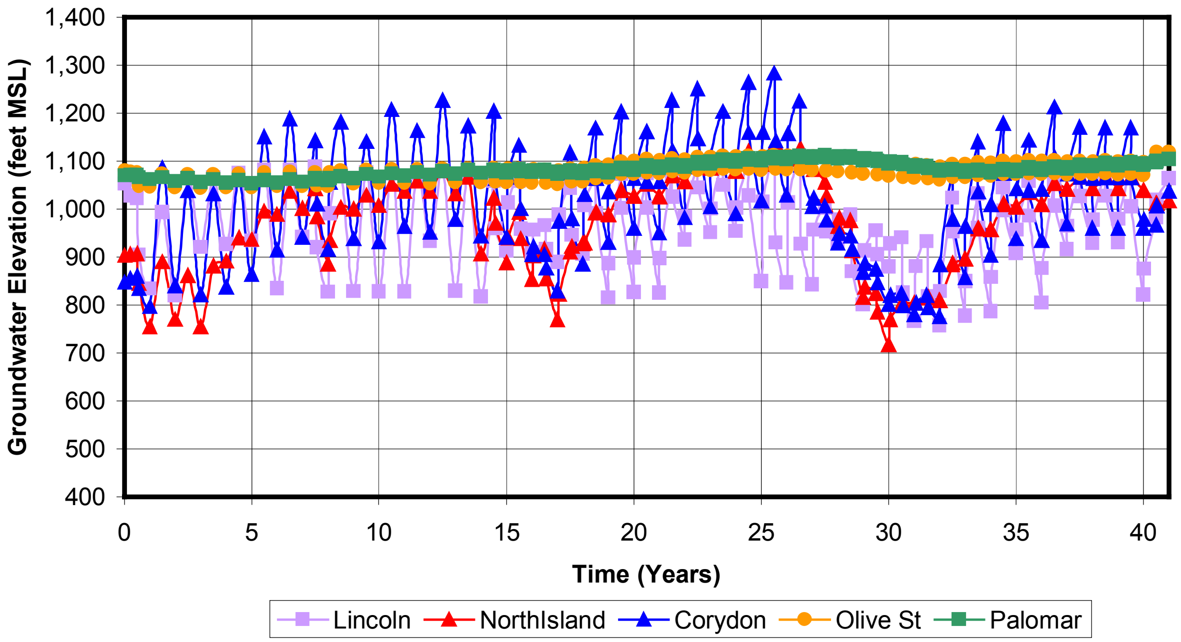


Figure 3
Alternative 2 Groundwater Results

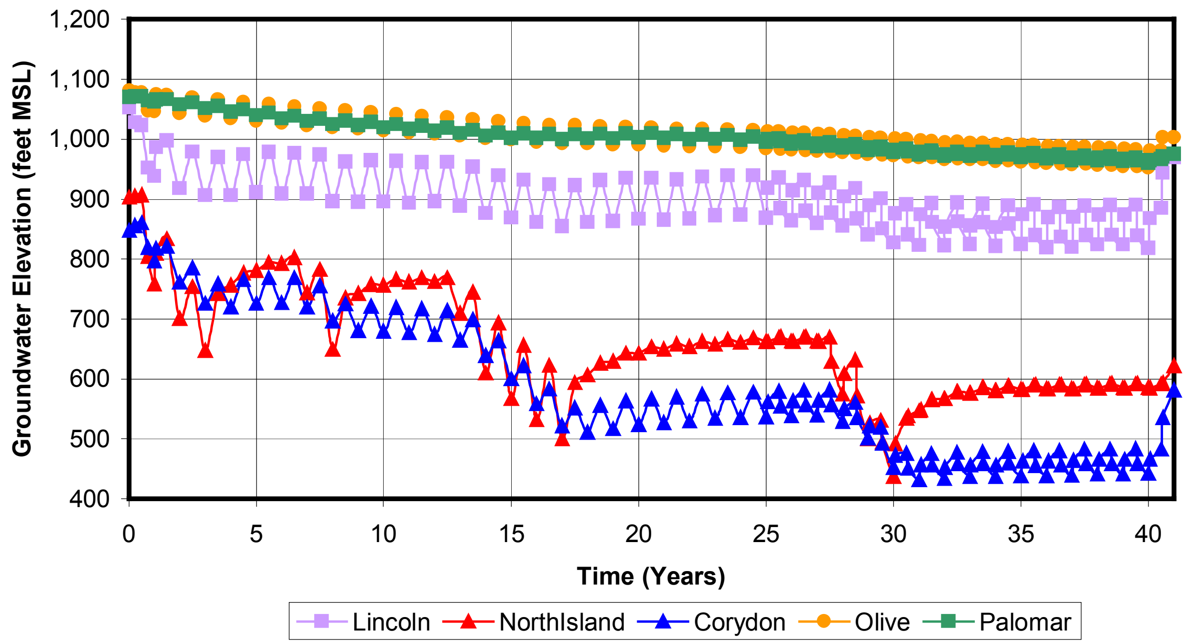


Figure 4
Alternative 3 Groundwater Results

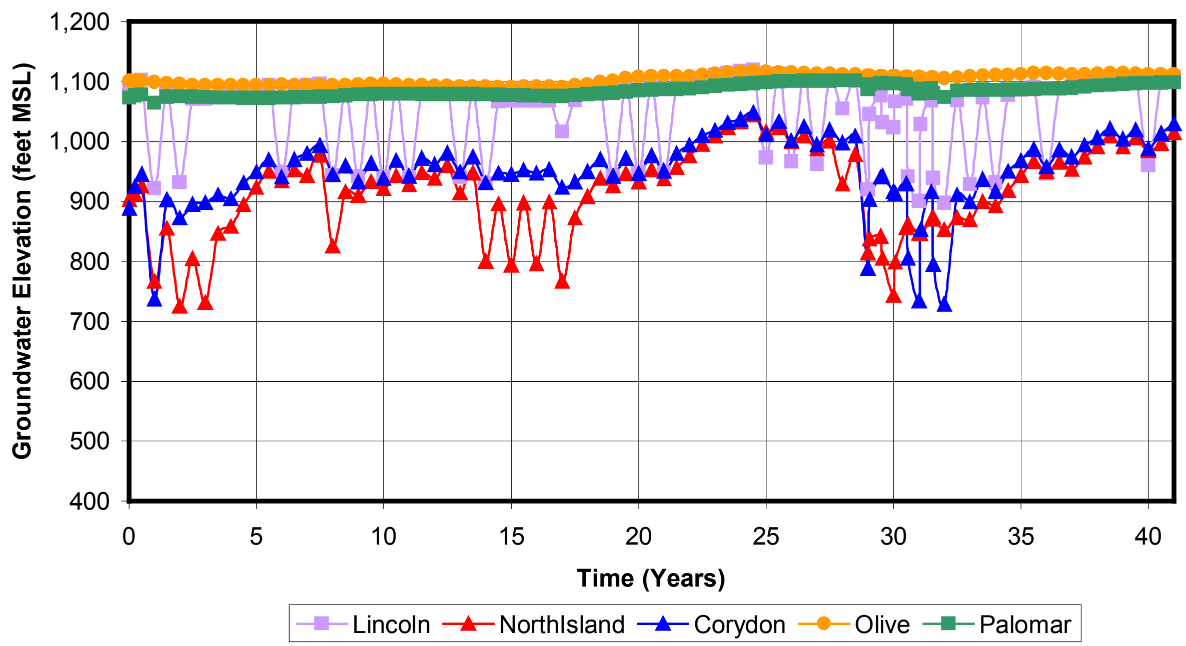


Figure 5
Alternative 4 Groundwater Results